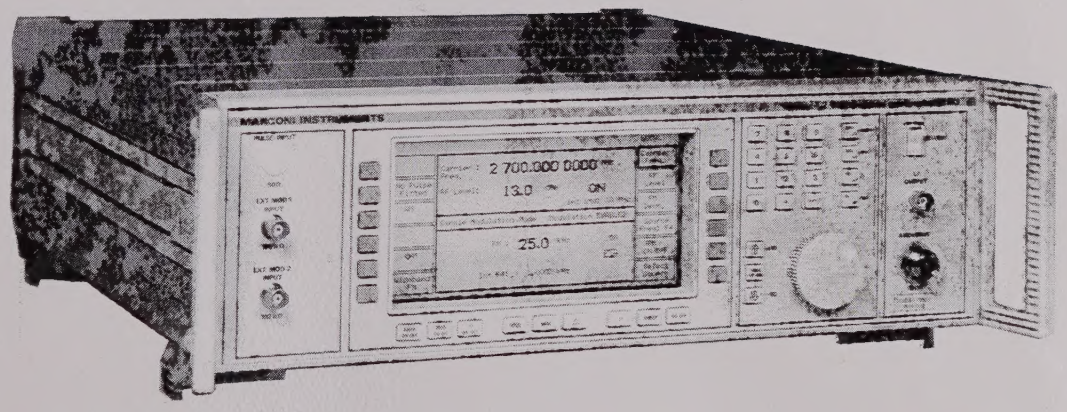
Marconi Instruments

AM/FM SIGNAL GENERATORS

2030 SERIES



Operating Manual

46881-976P

Aborting the sweep

Press *[Abort Sweep]*. The sweep is reset and the RF (or LF) signal is removed from the appropriate output socket. The *Sweep Parameters Menu* as shown in Fig. 3-1-21 is displayed. If the sweep is restarted with the signal disabled, the *[Abort Sweep]* key is not displayed thus giving the user an indirect indication that no signal is being output from the instrument.

UTILITIES

The utilities options are accessible from two primary menus, *Utilities Selection Menu 1* and *Utilities Selection Menu 2*. When a selection is made from either of these menus and [UTIL] is subsequently pressed, the primary menu is re-displayed. However, if instead a selection is made and then one of the other hard keys e.g. [SWEEP] is pressed, pressing [UTIL] subsequently once returns to the sub-menu, pressing it again returns to the primary menu. This provides an operating short-cut in that it allows a sub-menu to be re-accessed without first having to go again through the primary menu. This scheme does not apply to the *[Time & Date]* or to the *[Set Time & Date]* soft keys. The display for *Utilities Selection Menu 1* is shown in Fig. 3-1-28. To obtain *Utilities Selection Menu 2* from the menu, press *[Utils. Menu 2]*.

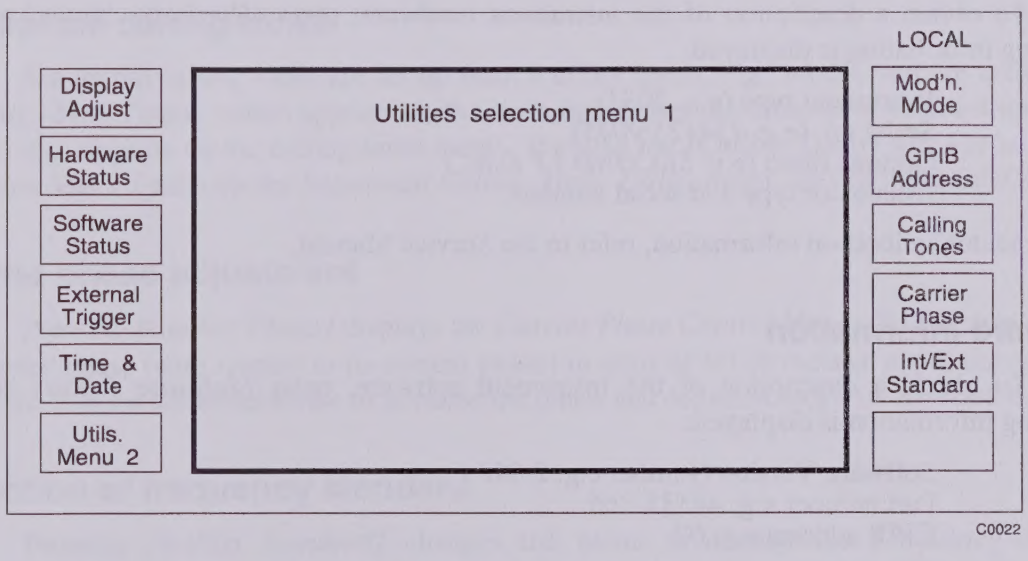


Fig. 3-1-28 Utilities selection menu 1

Adjusting the display

To adjust the display, press *[Display Adjust]*. The *Display Adjust* menu is displayed on the screen, see Fig. 3-1-29. The backlight, which is on when the instrument is switched ON, can be toggled ON or OFF using the *[Display ON/OFF]* key, and when ON can be varied in brightness by *[Dim]*, *[Medium 1]*, *[Medium 2]* and *[Bright]*. Contrast is adjusted with the control knob. Once adjusted, the LCD setting can be stored in the the non-volatile memory by pressing *[Save LCD Setting]*. The instrument always activates the backlighting whenever it is switched on.

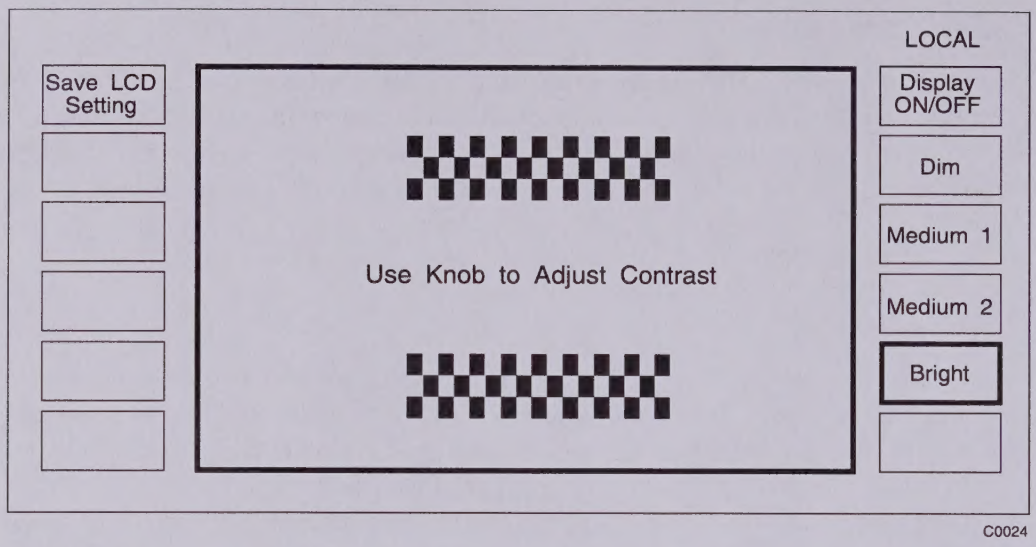


Fig. 3-1-29 Display adjust menu

Hardware information

To obtain a description of the instrument hardware, press *[Hardware Status]* and the following information is displayed:

Instrument type (e.g. *2031*)
Serial no. (e.g. *1543256/045*)
Options fitted (e.g. *SECOND LF OSC.*)
Attenuator type and serial number.

For attenuator calibration information, refer to the Service Manual.

Software information

To obtain a description of the instrument software, press *[Software Status]* and the following information is displayed:

Software Version Number e.g. *2.001*
Part number e.g. *44533-366*
GPIB address e.g. *07*

External trigger

The external trigger facility allows the rear panel TRIGGER input to be set up so as to initiate a defined change in the generator setting. To define the function press *[External Trigger]*. The display changes to show the *External Trigger Selection Menu* which has the following options:

[Sweep Start]	Starts the external sweep.
[Sweep Step]	Goes to next step of external sweep.
[Send Seq Tones]	Equivalent to *[Send Tones]* on main menu.
[Recall Up]	Recall next store.
[Recall Down]	Recall previous store.
[No Ext. Trigger]	Trigger ignored (default)

The external TRIGGER input requires a TTL type input and includes an internal pull-up resistor to +5 V. A switch closure to ground or an applied voltage transition from +5 V to 0 V on the rear panel socket initiates the defined trigger action.

Setting the modulation mode

Modulation mode selection allows the generator to be configured to provide carriers modulated by one, two or four (2 internal and 2 external) modulation sources.

Press *[Mod'n Mode]* to display the *Modulation Mode Selection Menu*, choose the type of modulation required by pressing *[Single]*, *[Dual]*, *[Comp]* or *[Dual Comp]*, see 'Modulation mode selection' above.

Setting the GPIB address

Press *[GPIB Address]* to display the *GPIB Address Change Menu*. To change the address, enter the address, in the range 0-30, via the numerical key pad and press [enter]. The data is then saved automatically in the non-volatile memory. For information on operating the instrument via the GPIB, refer to Chapter 3-2.

Sequential calling tones

Sequential calling tones are set up from a utility menu, Fig. 3-1-28, and are activated by pressing *[Send Tones]* which appears on the main menu after the tones have been set up. *[Send Tones]* also appears on the calling tones menu. Pressing the *[Calling Tones]* soft key at *Utilities Selection Menu 1* calls up the *Sequential Calling Tones Utility* menu, see 'SIGNALLING'.

Carrier phase adjustment

Pressing *[Carrier Phase]* displays the *Carrier Phase Control Menu*. To advance or retard the carrier phase (with respect to its current phase) in steps of $\pi/128$ radians, approximately 1.4°, rotate the control knob clockwise to advance the phase and counter-clockwise to retard the phase.

Selection of frequency standard

Pressing *[Int/Ext Standard]* changes the menu to display the *Frequency Standard Selection Menu* which controls the internal/external frequency standard facilities. The signal generator can be set to operate from an external standard or from the internal standard with or without the standard being provided on the rear panel FREQ STD IN/OUT connector.

The menu has the following options:

Output DISABLED	Internal standard disabled at the FREQ STD IN/OUT connector.
1 MHz Int. Std. *5 MHz Int. Std.* *10 MHz Int. Std.*	Internal standard with an output at the selected frequency on the FREQ STD IN/OUT connector.
1 MHz Ext. Std. *5 MHz Ext. Std.* *10 MHz Ext. Std.*	Accepts an external frequency standard at the selected frequency on the FREQ STD IN/OUT connector.

These settings are saved in non-volatile memory to ensure that the settings are recalled when power to the instrument is restored.

Selection menu 2

Press *[Utils Menu 2]* from *Utilities Selection Menu 1*. The display now changes to show *Utilities Selection Menu 2*, see Fig. 3-1-30. This menu allows access to the protected data. Utilities on this menu have either 1st or 2nd level protection.

If the instrument is locked, the appropriate level must be unlocked otherwise the utility will only be usable in a read only mode. To change parameters, the function must be unlocked. The procedure is:

[UTIL] ⇒ *[Utils. Menu 2]* ⇒ *[Lock & Unlock]* ⇒ *Function Unlocking Utility* menu ⇒ *[Unlock Level 1]* or, for servicing, *[Unlock Level 2]*.

The correct password must be entered. Many of these activities are intended for use in servicing and are described in the Service Manual.

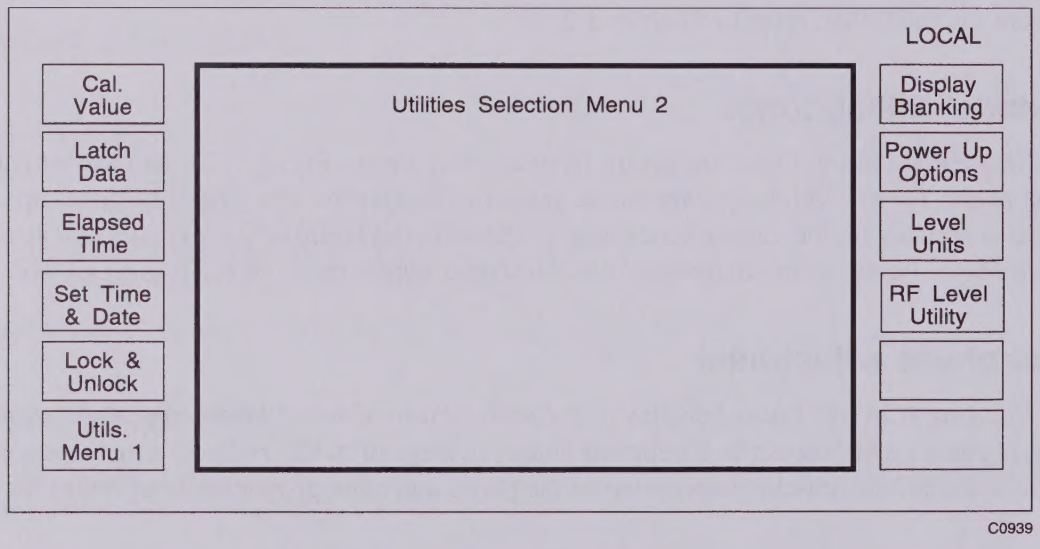


Fig. 3-1-30 Utilities selection menu 2

Calibration

Pressing *[Cal. Value]* brings the *Calibration Utilities Menu* to the display, see Fig. 3-1-31. This menu shows when the last complete check was made and when the next calibration check is due. It also shows the date on which the individual items were adjusted. It is possible to inspect the calibration value of these items but calibration cannot be carried out unless the protection facility is unlocked at Level 2. Full details regarding calibration can be found in the Service Manual.

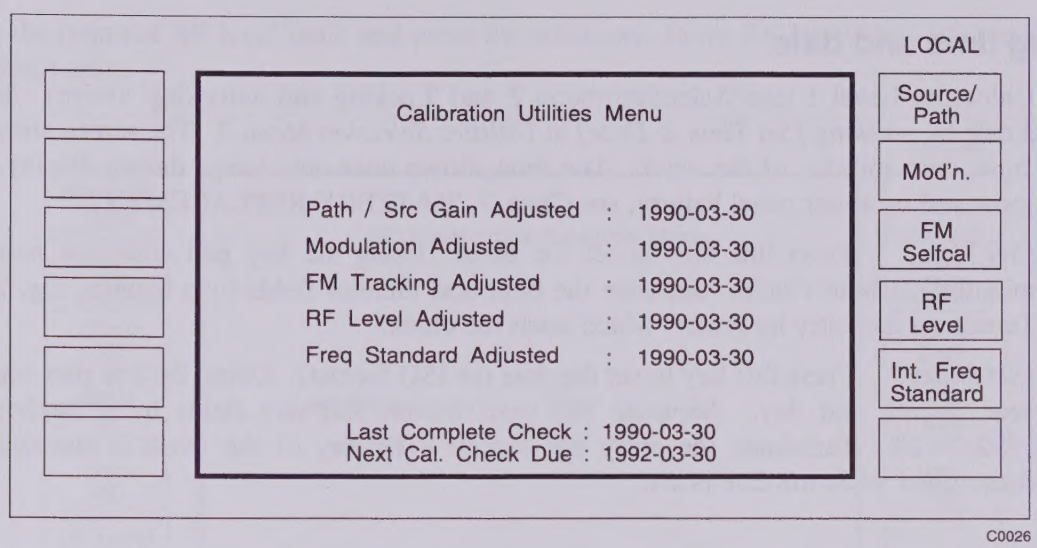


Fig. 3-1-31 Calibration utilities menu

Latch data

The latch data menu is intended for use as a diagnostic aid by allowing data to be sent to latches within the instrument. For further information consult the Service Manual.

Elapsed time

The elapsed time facility displays the number of operating hours since the function was last reset. Pressing *[Elapsed Time]* displays the number of operating hours and the date on which the function was last set to zero. This facility can be used to assess the instrument's operational reliability and utilisation.

Locking and unlocking

Press *[Lock & Unlock]*. When Level 1 and Level 2 are both locked, the menu displays three soft keys:

Unlock Level 1
Unlock Level 2
Serial No. Set

Press *[Unlock Level 1]* and the message *Enter 4 Digit Password*: will appear on the display. Level 1 is unlocked by entering the 4 digits on the key pad and pressing [enter]. The menu will change and two soft keys, *[Lock level 1]* and *[Lock Keyboard]*, will appear on the left-hand side. The default password is 1234. If this password is not recognised by the instrument, the password has been changed by your calibration/repair department personnel who should be consulted for further information. *[Unlock Level 2]* is only used during servicing. Refer to the Service Manual for details.

Setting time and date

Unlock to Level 1 (see 'Selection menu 2' and 'Locking and unlocking' above). Set the time and date by pressing *[Set Time & Date]* at *Utilities Selection Menu 2*. The screen shows the current time, date and day of the week. The time shown does not change during display. The clock is powered by a rear panel battery, see Chap. 2, 'BATTERY REPLACEMENT'.

[Set Time] Press this key to set the time. Using the key pad enter the hour and minutes (24 hour clock). Separate the hour and minutes fields by a hyphen, e.g. 21-30. Terminate the entry by [enter] which starts the clock.

[Set Date] Press this key to set the date (in ISO format). Using the key pad enter the year, month and day. Separate the year, month and day fields by a hyphen e.g. 1992-04-23. Terminate the entry by [enter]. The day of the week is automatically determined when the date is set.

Keyboard locking

Unlock to Level 1, see 'Selection menu 2' and 'Locking and unlocking' above. Keyboard operation is disabled by pressing *[Lock Keyboard]*. The instrument automatically returns to the main menu which indicates the locked status by displaying a key-shaped icon in the top left-hand corner of the display. The keyboard can be re-enabled by entering the 4 digit password for Level 1 using the key pad and pressing [enter]. The keyboard status is saved in the non-volatile memory.

Display blanking

To prevent sensitive data from being displayed, the 2030 Series Signal Generators include a display blanking facility. This allows various parts of the display to be replaced by a series of dashes so that values entered by the user or recalled from the memory will not be visible. The instrument must be unlocked to Level 2 to enable or disable this facility. Consult the Service Manual for further information.

Power up options

Unlock to Level 1, see 'Selection menu 2' and 'Locking and unlocking' above. Two options are available by pressing *[Power Up Options]* at *Utilities Selection Menu 2*. These options are *[Factory]* and *[Memory]*. When *[Factory]* is pressed, the factory set power up state is recalled. Pressing *[Memory]* causes *[Memory Number]* to appear at the right-hand side of the menu. To change the power up state of the instrument to a particular setting, enter the memory number of the full store on the key pad and press [enter].

RF level units

RF output level units can be altered using the *[Level Units]* key. The level units may be entered as an EMF or PD, and the logarithmic units can be referred to volts (dBV), millivolts (dBmV), microvolts (dBμV) or to 1 milliwatt into 50 Ω(dBm). Select the units by pressing *[Level Units]* which displays the *RF Level Units Selection Menu* shown in Fig. 3-1-32.

To change the default RF level units shown at switch on, first unlock the instrument to Level 1. This causes an additional soft key to be displayed in the top left box (see Fig. 3-1-32).

Select the required RF level units and press the additional *[Save RF Units]* key to save these as the default units.

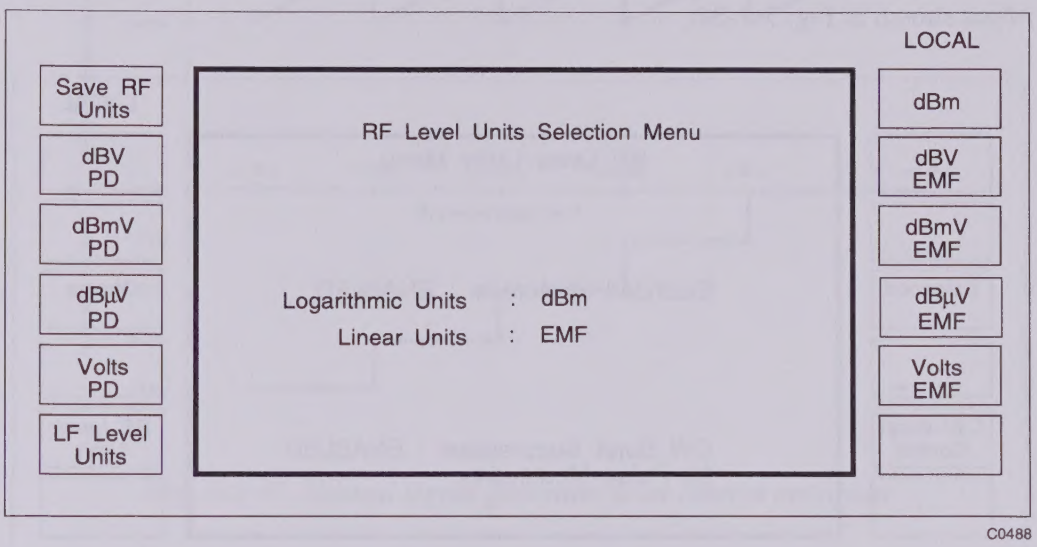


Fig. 3-1-32 RF level units selection menu (shown unlocked to level 1)

LF level units

LF level logarithmic units may be referenced to 1 volt EMF (dBV EMF), 1 millivolt EMF (dBmV EMF) or 1 milliwatt into 600 Ω(dBm). Linear units are always set EMF values.

Select the units by pressing the *[LF Level Units]* soft key on the *RF Level Units Selection Menu* which calls up the *LF Level Units Selection Menu* shown in Fig. 3-1-33.

To change the default LF level units shown at switch on, first unlock the instrument to Level 1. This causes an additional soft key to be displayed in the top left box (see Fig. 3-1-33). Select the required LF level units and press the additional *[Save LF Units]* key to save these as the default units.

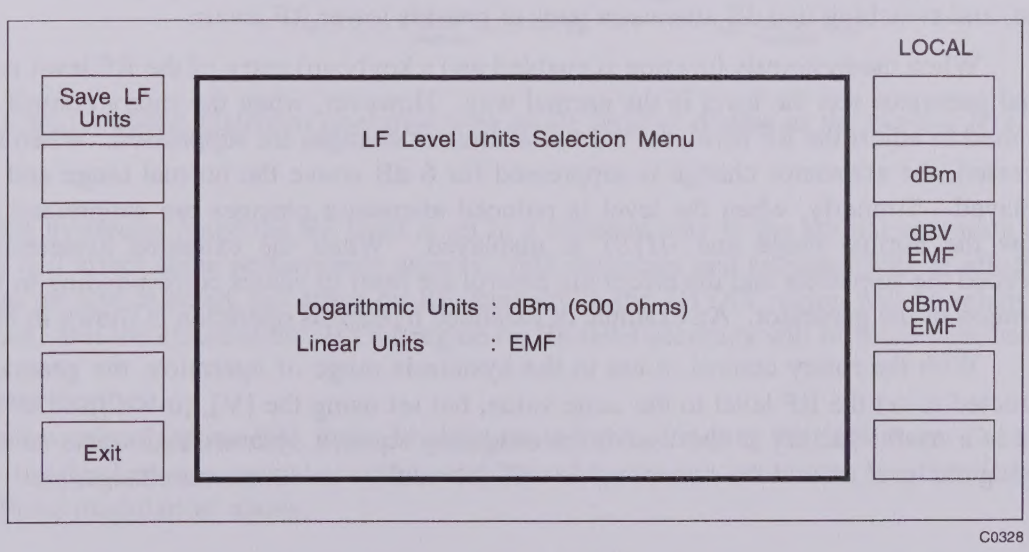


Fig. 3-1-33 LF level units selection menu (shown unlocked to level 1)

RF level utility

Selecting *[RF Level Utility]* from the *Utilities Selection Menu 2* displays *the RF Level Utility Menu* shown in Fig. 3-1-34.

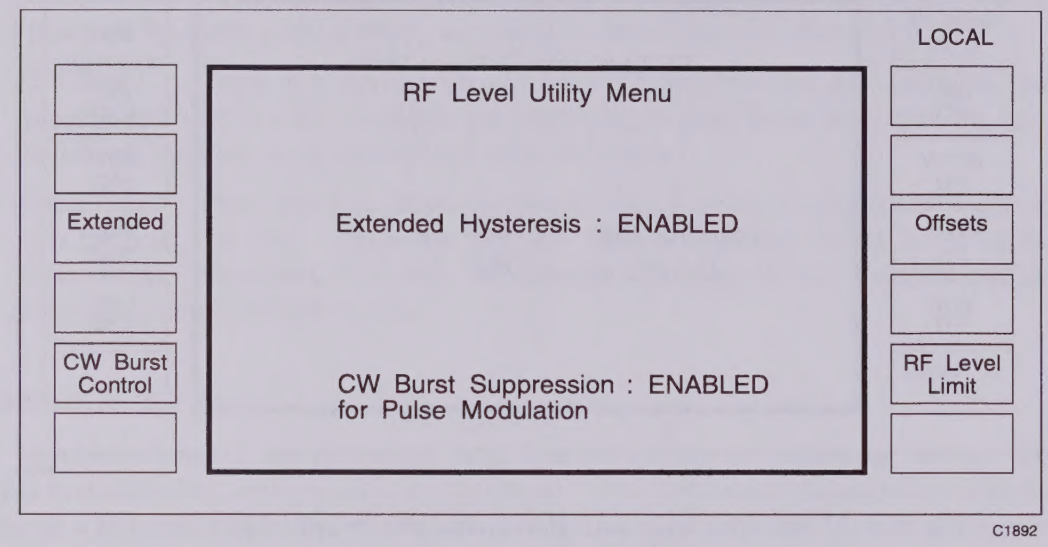


Fig. 3-1-34 RF level utility menu ([CW Burst Control] and associated text only appears when the relevant option is fitted)

Extended hysteresis

Pressing the *[Extended]* soft key toggles the status (Enable/Disable) of extended hysteresis. When enabled, this provides an electronic level function which uses the internal D/A converter, rather than the attenuators, to provide an uninterrupted (glitch-free) level control. This increases the electronic level control range to +12 to -18 dB. A *+HYST* or *-HYST* message is displayed on the *Sig Gen* menu to indicate when in hysteris and in which direction.

During normal operation the RF output is controlled as shown in Fig. 3-1-35 by electronically controlling the output level over a limited range (normally approximately 0 to +6 dBm) and switching in 6 dB attenuator pads to provide lower RF levels.

When the hysteresis function is enabled and a keyboard entry of the RF level is made, the signal generator sets the level in the normal way. However, when the rotary control is enabled and used to adjust the RF level, the normal attenuator changes are suppressed. When the level is increased, the attenuator change is suppressed for 6 dB above the normal range and *+HYST* is displayed. Similarly, when the level is reduced attenuator changes are suppressed for 12 dB below the normal range and *-HYST* is displayed. When the extended hysteresis range is exceeded the attenuator and the electronic control are reset to values corresponding to the normal operation of the generator. An example of extended hysteresis operation is shown in Fig. 3-1-36.

With the rotary control in use in the hysteresis range of operation, the generator can be instructed to set the RF level to the same value, but set using the [V], [mV], [µV] or [dB] keys. This is a useful facility if the user is investigating squelch systems and wants to ensure that varying the level around the current value will not result in an attenuator change.

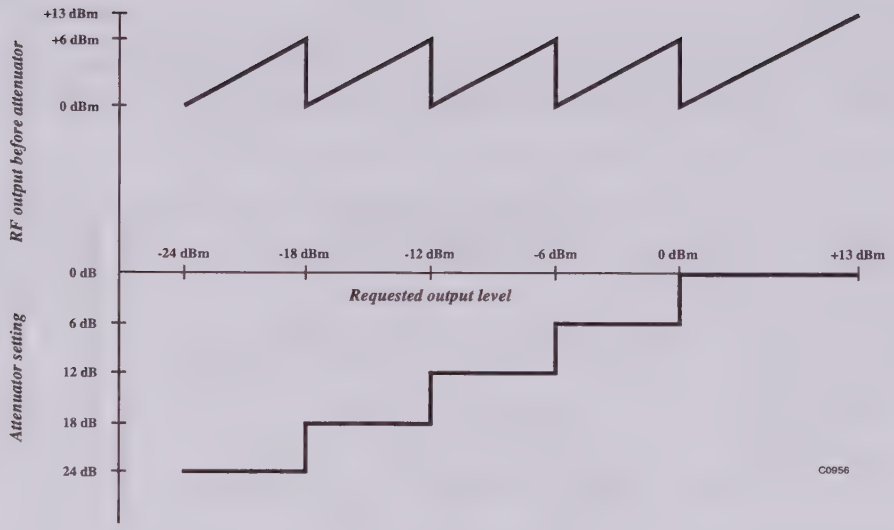


Fig. 3-1-35 Normal signal generator level control operation

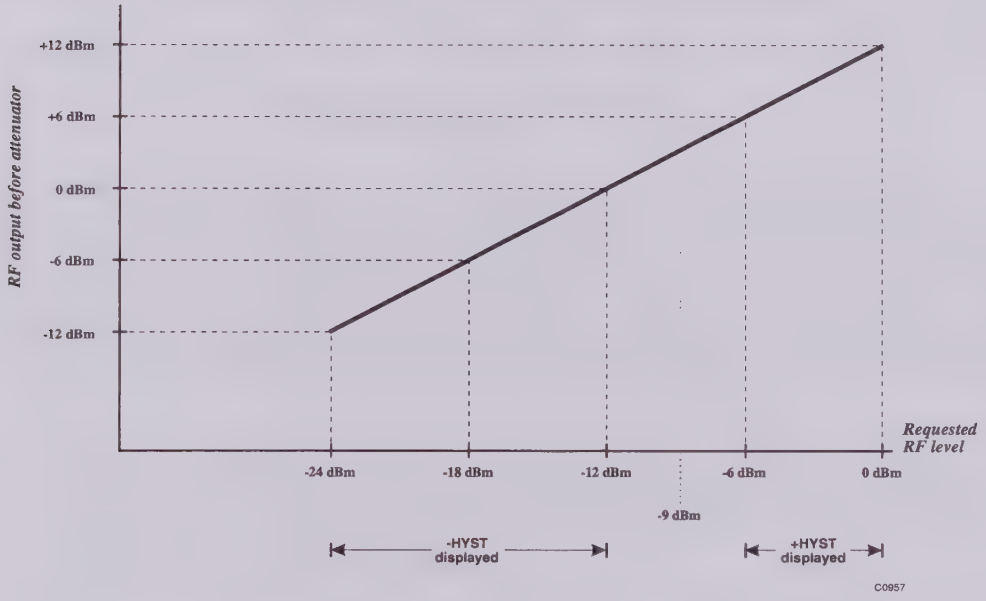


Fig. 3-1-36 Extended hysteresis operation with an RF level of -9 dBm as the starting level

Note...

In the hysteresis range the RF level is set in a different way to the normal operation and this will affect some performance aspects. AM distortion and accuracy will be affected. With no AM selected, the effect on RF accuracy in the +HYST region will be relatively minor. But the effect in the -HYST region on RF level accuracy will be more significant.

Burst control

Applies only if Option 002, Pulse Modulation is fitted. Pressing the *[CW Burst Control]* key toggles between normal operation and Burst Suppression operation. For details refer to 'Pulse modulation' above.

RF offset

With the instrument unlocked to Level 1, see 'Locking and unlocking' above, pressing *[Offsets]* produces the layout for the soft keys shown in Fig. 3-1-37.

Fig. 3-1-37 RF offset adjustment menu

To compensate for cable or switching losses or to standardize a group of instruments so that they give identical measurements, the RF output level can be offset by up to ±2 dB. This is done by selecting *[Offset Value]* and either keying in the value or making the adjustment with the control knob. A separate offset can be set for the carrier frequency range 10 kHz to 337.5 MHz and each octave above this. Offsets can be turned on or off individually using the *[Offset ON/OFF]* key or all offsets can be turned on or off via the *[Enable/Disable]* key.

Note...

This facility is replaced by a more versatile system on generators supplied with Option 008, RF profiles and complex sweep (see Annex D).

RF level limit

With the instrument unlocked to level 1, see 'Locking and unlocking' above, pressing the *[RF Level Limit]* key causes the *RF Level Limit Menu* shown in Fig. 3-1-38 to be displayed.

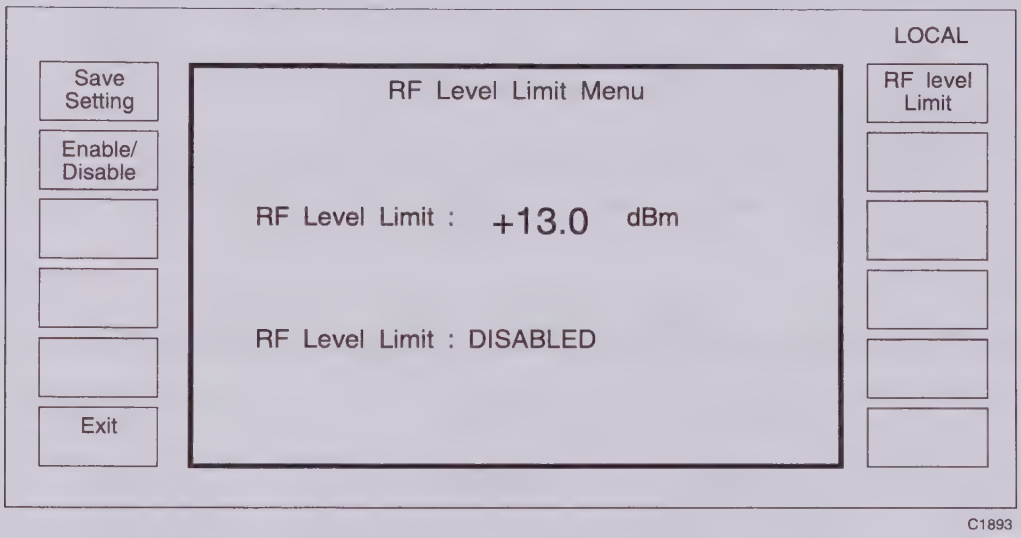


Fig. 3-1-38 RF level limit menu

The maximum peak RF level output can be specified in the range -138 to +19 dBm for the standard instrument or in the range -138 to +25 dBm for an instrument fitted with the high output power Option 003. As a result the keyed-in RF output value can be limited as a means of protecting sensitive devices connected to the RF output of the signal generator. Alternatively, the RF output power can be extended by an additional 6 dB for overrange testing. If the requested output level is in the overrange region the *uncal* message is displayed on the *Sig Gen* menu.

The RF level limit is set by selecting *[RF Level Limit]* and entering the value required. Units may be μV, mV or dB. The choice of volts EMF, volts PD and the dB reference is made by using the RF Level Units utility (see 'RF level units' above). The RF level limit can be turned on or off by means of the *[Enable/Disable]* key.

By pressing the *[Save Setting]* key, the RF level limit value and status is stored to non-volatile memory which is recalled at switch-on and during an instrument reset.

Note...

When in the overrange region, the signal generator is capable of generating much higher signal levels. If the frequency is set below 21.09375 MHz and the RF output is not terminated in 50 Ω, the RPP may be tripped by the internal RF signal. If this happens the RPP can only be reset if a 50 Ω termination is connected to the RF OUTPUT socket.

LOW FREQUENCY OPERATION

The instrument has two modes of LF operation. The LF output can be used either as a modulation signal monitor or as an independent low frequency generator. Pressing [LF] displays either the *LF Monitor Menu* or the *LF Generator Menu*, depending on which mode was last selected.

LF monitor

The left-hand side of the *LF Monitor Menu*, varies according to the modulation mode; single, composite, dual or dual composite. In each case the right-hand side is occupied by a single soft key, *[LF Gen.]*.

TABLE 3-1-1
LIST OF AVAILABLE SOFT KEYS FOR DIFFERENT MODULATION MODES

Single	Composite	Dual	Dual Composite
Mod. Drive	Mod. Drive	AM Drive	AM Drive
Mod. Source	Mod. 1 Source	AM Source	AM 1 Source
-	Mod. 2 Source	-	AM 2 Source
-	-	FM/ΦM Drive	FM/ΦM Drive
-	-	FM/ΦM Source	FM/ΦM 1 Source
-	-		FM/ΦM 2 Source

Modulation source monitoring

Internal sources only may be monitored. To monitor a modulating signal source, press the appropriate key. The source monitor level and the source information appear on the display. The modulating signal output is fed to the LF OUTPUT socket at a fixed level of 1 V.

Modulation drive monitoring

Modulation drive monitoring is intended for the user to monitor complex modulating signals from both internal and external sources. To monitor a modulation drive, press the appropriate key. The LF Monitor Level and the selected drive are displayed.

When the summed AM drive signal is selected, a signal which is the sum of both AM channels is fed to the LF OUTPUT socket, if in a composite or dual composite mode. The LF level function controls the output level at 100% depth, therefore the actual output voltage depends on the modulation depth. If AM is turned off, the associated LF output is removed.

The summed FM/ΦM drive signal is also fed to the LF OUTPUT socket. The signal is the sum of both FM/ΦM channels. The FM drive signal at the monitored point is nominally 1 V but varies over a range of approximately 3 dB (except at deviation values below about 1 kHz) depending on the set modulation and the carrier frequency selected. If FM/ΦM is turned off, the LF signal is removed. If one component of a composite modulation setting is turned off, the component which is left on remains at its original level.

Note...

Wideband FM and pulse modulating signals are not accessible via the monitor mode.

Use as an independent LF generator

To use the instrument as an independent LF generator, select *[LF Gen.]* at the *LF Monitor Menu*. The *LF Generator Menu* appears on the display as shown in Fig. 3-1-39.

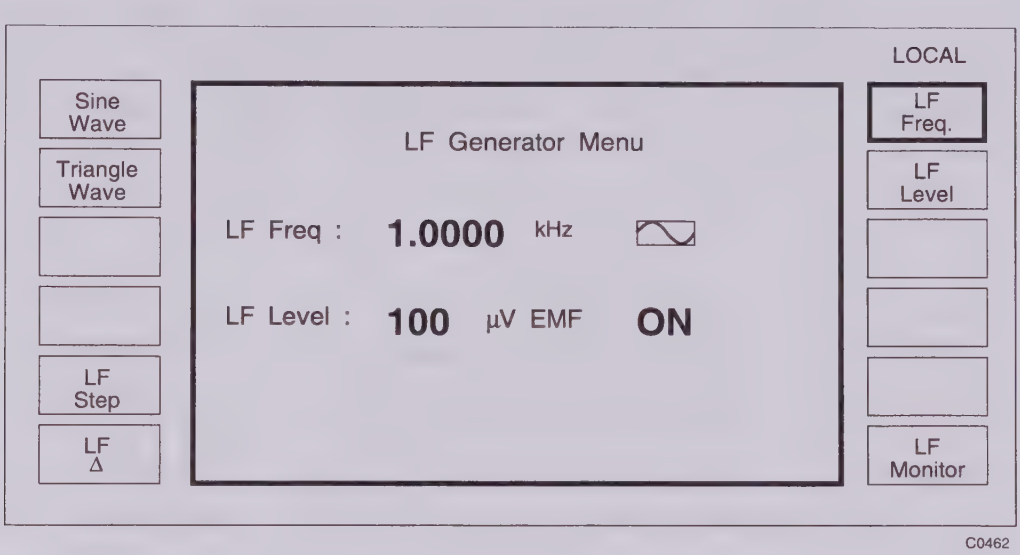


Fig. 3-1-39 LF generator menu

In this mode, one internal oscillator must be used exclusively for this task. Consequently if only one oscillator is fitted, no internal modulation is available to the signal generator while the LF generator is in use. If a second oscillator is fitted, only one is available to the signal generator.

LF frequency and LF level are adjusted by pressing the appropriate key and entering the value via the numerical key pad and pressing [enter]. To set step values, press *[LF Step]* for the *LF Step Menu*. *[Freq. Step]* or *[Level Step]* can be selected and the values entered as before. To display the *LF Total Shift Menu*, press *[LF Δ]*.

To regain the oscillator as a modulation source, select the monitor mode.

Note...

The LF output is entered as V/mV/µV or dBm/dBV/dBmV representing the open circuit voltage fed to a high impedance, but the steps are entered in dB and the control knob has a fixed resolution of 0.1 dB.

MEMORY

Memory recall

Pressing the [MEM] hard key after switch on, causes the *Memory Recall Menu*, Fig. 3-1-40, to be displayed. There are four types of recall, full, partial, carrier frequency and sweep. Provision is made for an option not to recall the carrier frequency for full and partial stores. This allows one carrier frequency to be used with a series of stored settings. Pressing *[Inhibit ON/OFF]* turns the option ON and OFF. The state of the option is indicated on the display.

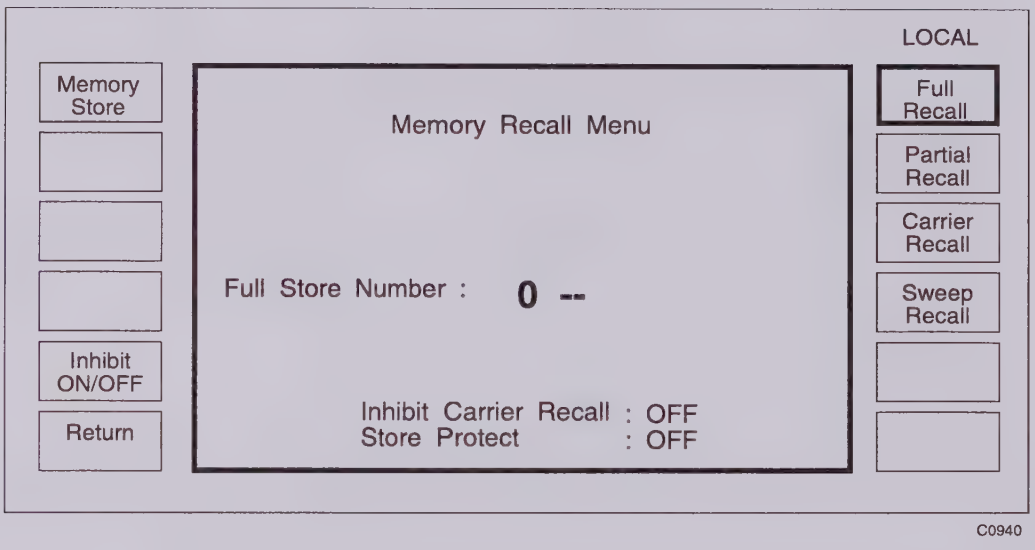


Fig. 3-1-40 Memory recall menu

Full recall

Selecting *[Full Recall]* enables the recall of a complete instrument setting, i.e. carrier frequency, RF level, modulations and their increments, ON/OFF and source information. Also recalled are all 6 modulation oscillator frequencies, plus one increment, and the LF Generator/Monitor setting. *[Inhibit ON/OFF]* provides the option not to recall the carrier frequency setting. The state of the option is indicated on the display. There are 50 locations (numbered 0 to 49) for full recall. A further location (50) allows the factory default settings to be recalled. The factory default settings are listed in Table 3-2-1.

Partial recall

This is a less comprehensive recall of only those parameters which currently affect the RF output; carrier frequency, RF level, modulations in use (without increments), ON/OFF and source information and the two modulation oscillator frequencies in use. As with full store, the option not to recall the carrier frequency is provided. There are 50 locations (numbered 0 to 49) for partial storage.

Carrier recall

The carrier frequency store has 100 locations (numbered 0 to 99) which may be recalled when required.

Sweep recall

The sweep store has 20 locations (numbered 0 to 19) containing complete sets of sweep parameters which may be recalled when required.

Note...

Sweep parameters can be recalled whether the instrument is in sweep mode or not. They are only used when sweep is selected.

Recalling data

To recall data, press the soft key for the type of recall required, e.g. *[Carrier Recall]* and select the location by means of the key pad. The ⇑ and ⇓ keys can be used to recall the next locations. Pressing *[Return]* recalls the location last specified on the numerical key pad.

Stores can be incremented or decremented externally by means of the SWEEP TRIGGER socket (see 'External trigger' above).

Note...

The settings for the sequential calling tones are recalled via the calling tones menu in UTILITIES, see Fig. 3-1-28. These stores can be erased from the *Store Erase Menu.*

Inhibit ON/OFF

When recalling full or partial stores it is sometimes useful for the existing carrier frequency setting to remain and not be replaced by the stored setting. The Inhibit Carrier Recall facility offers this capability. To prevent the current carrier frequency from being replaced use the *[Inhibit ON/OFF]* key to set the *Inhibit Carrier Recall* annunciator to *ON*.

To allow the carrier frequency setting to be overwritten use the *[Inhibit ON/OFF]* key to set the *Inhibit Carrier Recall* annunciator to *OFF*.

Memory stepping facility

The [Sig Gen] key has a toggle action in that pressing the key a second time displays the *Memory Stepping* menu shown in Fig. 3-1-41. This facility enables the memory to be stepped up and down from a start location (selected using the *Memory Recall Menu*), whilst displaying the settings for that memory.

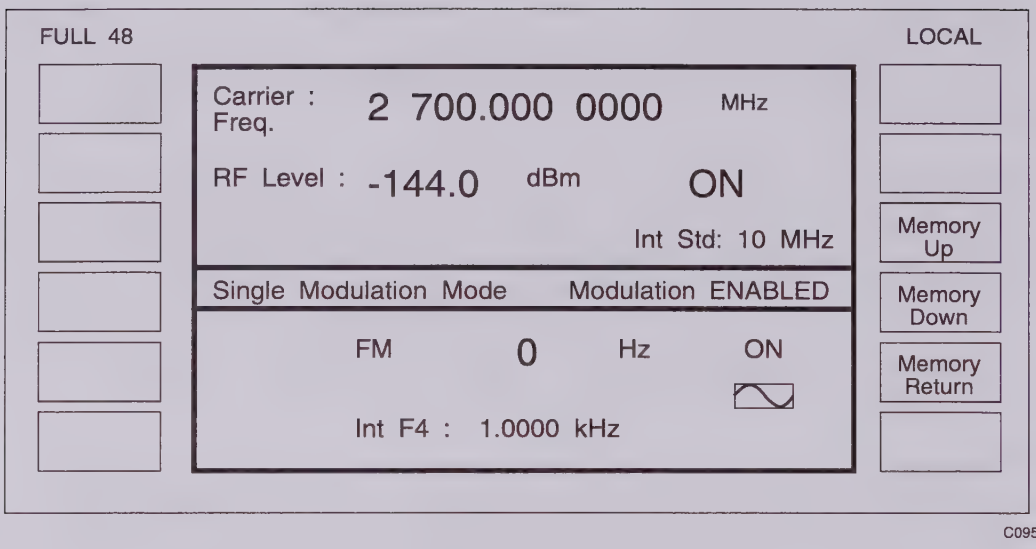


Fig. 3-1-41 Memory stepping menu

Pressing *[Memory Up]* or *[Memory Down]* respectively increments or decrements the memory location. With each step the settings stored in the location are displayed together with, at the top left of screen, the memory type and location e.g. *Full 48*. Incrementing and decrementing can also be done externally by means of the SWEEP TRIGGER socket (see 'External trigger' above). Pressing *[Memory Return]* at any time returns to the start location.

When a limit is reached, e.g. for Full Recall locations 0 and 49, a further step will reset to the start location. But note that if the start location coincides with a limit, trying to step past that limit will cause the limit and start locations (in this case the same numbered locations) to be alternately displayed. To make the user aware of this situation, the message *At Top Limit* or *At Bottom Limit* is displayed at the top centre of screen.

Memory store

Pressing the *[Memory Store]* soft key on the *Memory Recall Menu* causes the *Memory* Store Menu, Fig. 3-1-42, to be displayed. There are four types of store, full, partial, carrier frequency and sweep.

To prevent the accidental overwriting of memory contents, a store protection facility is provided. If this feature is enabled, the screen legend will indicate *Store Protect: ON* and the store key legends at the right of the screen will not appear.

Note...

Sequential calling tone sequences can be stored from the *Sequential Calling Tones Utility* menu. There is provision for storing up to 20 tone sequences.

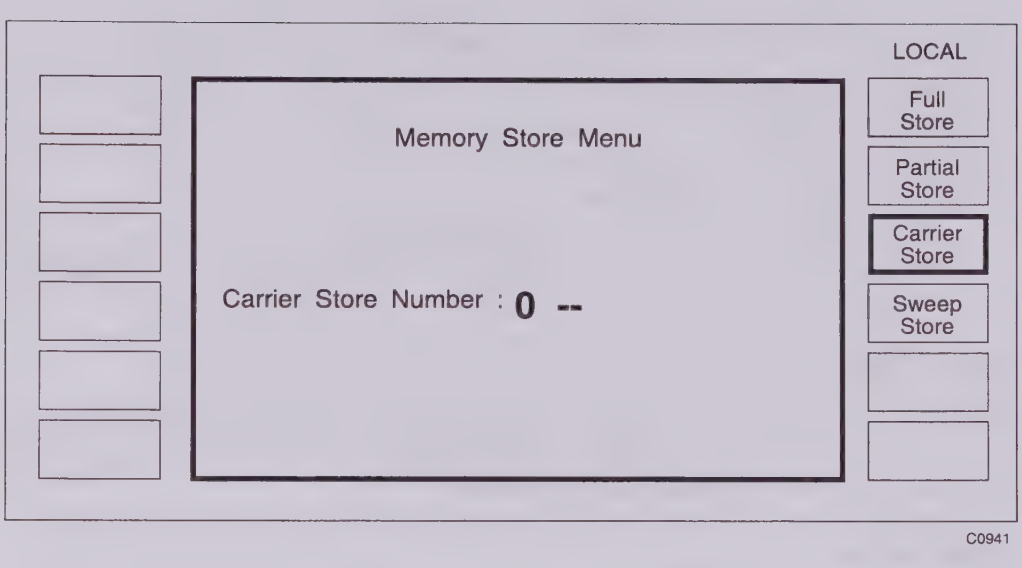


Fig. 3-1-42 Memory store menu

Full store

Selecting *[Full Store]* enables the storage of a complete instrument setting, i.e. carrier frequency, RF level, modulations and their increments, ON/OFF and source information. Also stored are all 6 modulation oscillator frequencies, plus one increment, and the LF Generator Monitor setting. There are 50 locations (numbered 0 to 49) for full storage. A further location (50) holds the factory default settings. This memory cannot be written to by the user. The factory default settings are listed in Table 3-2-1.

A Full Store contains the following information:

Carrier frequency setting
Carrier frequency step size
RF level setting
RF level step size
All modulation settings
All modulation step sizes
Modulation mode and status
All six internal oscillator frequency settings
The modulation frequency step size
LF generator frequency setting
LF generator frequency step size
LF generator level setting
LF generator level step size
LF monitor settings
Display blanking settings

Partial store

This is a less comprehensive store of only those parameters which currently affect the RF output; carrier frequency, RF level, modulations in use (without increments), ON/OFF and source information and the two modulation oscillator frequencies in use. There are 50 locations (numbered 0 to 49) for partial storage.

A Partial Store contains the following information:

Carrier frequency setting
RF level setting
The active modulation settings
Modulation mode and status
The frequency of the active modulation frequencies
Either the LF generator frequency and level setting or the LF monitor setting (depending on which mode is selected)

Carrier store

The carrier frequency store has 100 locations (numbered 0 to 99) for the storage of carrier frequency only. This store can be used in conjunction with the full and partial stores to apply a set of test conditions to a range of frequencies.

Sweep store

The sweep store has 20 locations (numbered 0 to 19) for the storage of complete sets of sweep parameters.

Storing data

To store data, press the soft key for the type of store required, e.g. *[Partial Store]* and define a store location via the numerical key pad, then press [enter].

Note...

The settings for the sequential calling tones are stored via the calling tones menu in UTILITIES, see Fig. 3-1-28. These stores can be erased from the *Store Erase Menu.*

Store erase

Unlock to Level 1. Pressing *[Store Erase]* causes the *Store Erase Menu* to appear on the screen. The opportunity to erase all the stores of a given type is available by pressing the relevant key and then pressing *[Erase].*

Frequency hopping

Carrier frequency hopping is a GPIB operation where the instrument can be instructed to hop between any of the frequencies contained in the carrier frequency stores and a sequence of up to 1024 hops may be entered. The time interval between hops can also be entered .

Before executing a carrier hopping sequence, the frequencies must be loaded into the carrier frequency stores (0 - 99). This can be achieved via the GPIB using the following commands -

CFRQ < frequency value >
STO:CFRQ < store number >

To enter the frequency hopping mode, enter the following GPIB commands -

IMODE SWEEPER
SWEEP:TYPE HOP

This will cause the screen as shown in Fig. 3-1-43 to appear on the signal generator -

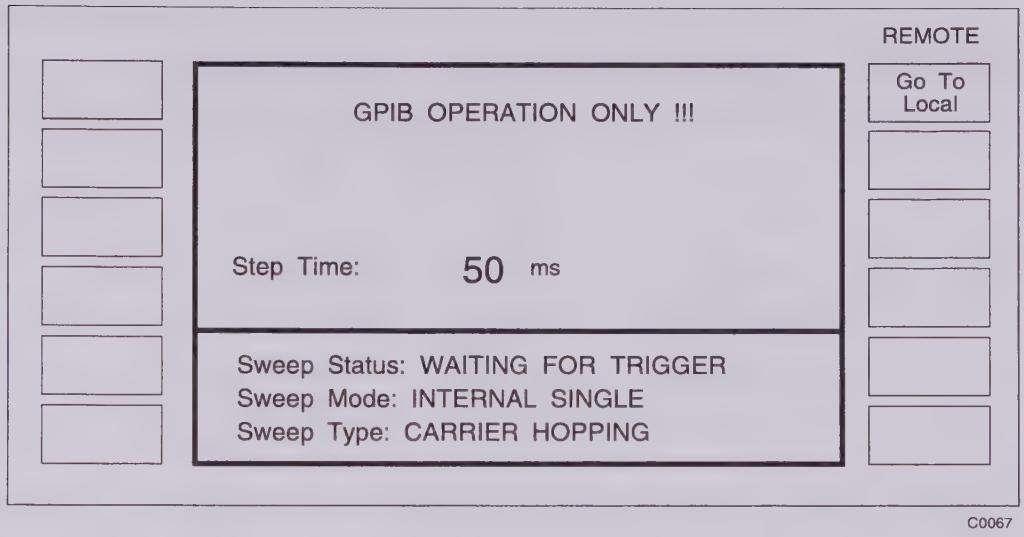


Fig. 3-1-43 Frequency hopping menu

To load in a sequence, the following command is used -

HOPSEQ<n0>,<n1>,<n2>,<n3>,<n4>.....

where <n0> - <n> are numeric values in the range 0-99 corresponding to the carrier frequency store at which the necessary frequency is stored. The hopping sequence length is determined by the amount of numbers entered.

The other parameter that can be set to control the hopping sequence is the time between steps. This is done using the command -

SWEEP:HOP:TIME < t >

where t represents the number of milliseconds.

The 100 frequencies are precalculated and loaded into a software sweep table using the GPIB command -

SWEEP:CALC

Note:...

If any of the carrier frequency stores have become corrupt and so result in a checksum error, the following message will appear in the centre of the screen -

CARRIER STORE < x > CORRUPTED.
RE - ENTER FREQUENCY.

where x is the corrupted store number.

With the frequencies, sequence and step time loaded, the hopping operation is controlled in the same manner as the ordinary sweeps by using the following commands -

SWEEP:GO	starts the hopping sequence (and will do any precalculation if required).
SWEEP:HALT	pause the hopping sequence.
SWEEP:UP	go up to the next step while paused.
SWEEP:DN	go down to previous step while paused.
SWEEP:CONT	continue hopping sequence.
SWEEP:RESET	reset sequence to start value.

When paused the carrier store number is displayed on the screen.

Note...

There are no markers available and the operation of transferring the paused value to the main parameter is not permitted.

To enter a new sequence use the HOPSEQ command but the number 255 is inserted at the beginning of the string.

e.g. existing sequence - 0, 6, 53, 72, 43, 96

sequence required - 22, 16, 7, 41, 59, 66

send GPIB command -

```
HOPSEQ  255,22,16,7,41,59,66
```

To add to an existing sequence use the HOPSEQ command without 255 at the beginning of the string.

e.g. existing sequence - 12, 24, 36, 48

sequence required - 12, 24, 36, 48, 60, 72, 84

send GPIB command -

```
HOPSEQ  60,72,84
```

To determine the length of the hopping sequence the following GPIB command is used -

```
HOPSEQ?
```

This returns a value 1 - 1024.

Like other sweep settings the frequency hopping mode can be set to -

single sweep (internal trigger),
continuous sweep (internal trigger) or
external sweep (external trigger)

by using the following commands -

SWEEP:MODE SNGL
SWEEP:MODE CONT
SWEEP:MODE EXT

For externally triggered operation the trigger facility can be used in the same manner as another sweep function.

ERROR HANDLING

Errors may be divided into three groups - foreground errors generally caused by a user, background errors which represent a condition of the instrument and GPIB errors which occur only when the unit is being controlled by a GPIB controller.

Foreground errors

Attempts to set the instrument to a parameter value outside its known range result in the generation of an error message.

For example, trying to select a carrier frequency above or below the specified range results in the message *Carrier Outside Limits* being displayed at the top of the screen.

Foreground errors are cleared automatically when a correct entry is made by the user.

Background errors

An incorrect operating condition within the instrument automatically generates an error message to warn the operator. For example, if the internal frequency standard should fail the message *Int. Standard Failure* will be displayed at the top of the screen.

GPIB errors

Errors caused by incorrect programming are displayed at the top of the screen and may also generate a Service Request if the relevant status registers are set.

Error display - Front panel

Errors are displayed as a single line of text at the top of the screen. If more than one error is present an internal priority ordering algorithm determines which error is displayed.

Error display - GPIB

When an error occurs, its number is entered into the Error Queue. Errors are not removed from the queue when they are cleared, but only by the ERROR? query, which returns the error at the head of the queue, or by the *CLS command which clears the whole queue. When the queue contains an error entry, a bit (<erb>) on the status byte is set.

The error queue has a capacity of 100 error numbers. If an error occurs while the queue is full the last error number is replaced with 255 so that the ERROR? query returns a value of 255 to indicate a full queue. An empty queue returns a value of 0 following an ERROR? query.

In addition to the error queue entry, the appropriate bit in the Standard Event Register will also be set (one of <cmd>, <exe>, <dde> or <qye>). Many background errors are also reported in the Hardware and Coupling Status Registers. For the above registers see Chap. 3-2.

ERROR MESSAGES

TABLE 3-1-2 BACKGROUND ERRORS

Error No.	Error Type	Descriptive text	Error No.	Error Type	Descriptive text
1	dde	RPP Tripped	6	dde	VCXO Out of Lock
2	dde	Fractional N Out of Lock	7	dde	Ext1 Too Low
3	dde	Int. Standard Failure	8	dde	Ext1 Too High
4	dde	Ext. Standard Failure	9	dde	Ext2 Too Low
5	dde	Incorrect Ext. Standard	10	dde	Ext2 Too High
11	-	-	16	-	-
12	-	-	17	exe	RF Level limited by AM
13	-	-	18	exe	FM limited by Carrier
14	-	-	19	exe	WBFM limited by Carrier
15	-	-	20	exe	AM2 limited by AM1
21	exe	FM2 limited by FM1	26	dde	Real Time Clock Problem
22	exe	PM2 limited by PM1	27	dde	Calibration Date Expired
23	exe	Steps limited by Span	28	dde	Pad Calibration Checksum
24	exe	FM Selfcal Error	29	dde	RF Calibration Checksum
25	dde	Internal Osc.1 Missing	30	dde	FM Calibration Checksum
31	dde	Path/Source Calibration	36	-	-
32	dde	Absolute Mod. Calibration	37	-	-
33	dde	Freq. Std. Calibration	38	-	-
34	-	-	39	-	-
35	-	-	40	-	-

TABLE 3-1-3 FOREGROUND ERRORS

Error No.	Error Type	Descriptive text	Error No.	Error Type	Descriptive text
46	exe	Recall Checksum	51	exe	Carrier Outside Limits
47	exe	Incorrect Setup	52	exe	RF Level Outside Limits
48	exe	Invalid Memory Number	53	exe	Mod Rate Outside Limits
49	exe	MODULATION NOT ENABLED	54	exe	LF Freq. Outside Limits
50	exe	Out of Range	55	exe	LF Level Outside Limits
56	exe	AM Outside Limits	61	exe	RF Level Step Too Big
57	exe	FM Outside Limits	62	exe	Mod Rate Step Too Big
58	exe	PM Outside Limits	63	exe	LF Freq. Step Too Big
59	exe	WBFM Outside Limits	64	exe	LF Level Step Too Big
60	exe	Carrier Step Too Big	65	exe	AM Step Too Big
66	exe	FM Step Too Big	71	exe	Sweep Stop Out of Range
67	exe	PM Step Too Big	72	exe	Sweep Steps Out of Range
68	exe	Invalid Latch Number	73	exe	Sweep Time Out of Range
69	exe	Invalid Latch Data	74	exe	Sweep Marker Out of Range
70	exe	Sweep Start Out of Range	75	exe	Attenuator EAROM Read
76	exe	Attenuator EAROM Write	81	exe	EAROM Wrap Around Error
77	-	-	82	exe	Continuous Tone Checksum
78	-	-	83	exe	Sequential Tone Checksum
79	exe	EAROM Write Error	84	exe	Tone data Out of Range
80	exe	EAROM Read Error	85	exe	Tone Offset Out of Range

TABLE 3-1-3 FOREGROUND ERRORS (continued)

86	exe	Clock Data Entry Error	91	exe	RF levelling fault
87	exe	At Top Limit	92	exe	REPEAT THIS CALIBRATION
88	exe	At Bottom Limit	93	-	-
89	exe	Ext. Trigger Disabled	94	-	-
90	dde	Int. Std. Not Selected	95	-	-

TABLE 3-1-4 GPIB ERRORS

Error		Descriptive text	Error		Descriptive text
No.	Type		No.	Type	
101	-	-	106	cmd	Data Expected
102	cmd	Mnemonic Fault	107	cmd	Illegal Data
103	cmd	Block Definition	108	cmd	Terminator Expected
104	cmd	Block Size	109	cmd	GET Error
105	cmd	Numeric Syntax	110	cmd	EOM Error
111	exe	Illegal Modulation Mode	116	qye	Unterminated
112	exe	No Such Monitor Mode	117	qye	Interrupted
113	exe	Cannot Monitor	118	qye	Deadlock
114	exe	Instrument Mode Wrong	119	cmd	Missing Quote
115	cmd	Lost Data After Comma	120	cmd	Terminator Expected
121	exe	String Length	126	exe	Illegal Seq Tones Mode
122	exe	Illegal Tone Character	127	exe	Overflow
123	exe	Illegal Duration Char	128	cmd	Data Too Long
124	exe	Illegal Standard	129	exe	Voltage Type Error
125	exe	Illegal Save Destination	130	exe	Sweep Not Possible
131	exe	Unknown Cal Point	136	exe	Unknown Freq. Standard.
132	exe	Unknown RF Band	137	exe	User Data Locked
133	exe	Unknown Instrument Mode	138	exe	Trigger Unknown
134	exe	User Data Checksum	139	exe	Illegal Tones Operation
135	qye	Query Lost after arb. char	140	cmd	Error in Char Data
141	exe	Wrong RF units	146	exe	Wrong Family For Command
142	cmd	Data Unknown	147	exe	Not Suitable For Hopping
143	exe	Negative Value Illegal	148	exe	Hopping Sequence Full
144	exe	Illegal Modulation Mode	149	-	-
145	exe	Unavailable Mod Source	150	-	-

TABLE 3-1-5 FATAL ERRORS

Error		Descriptive text	Error		Descriptive text
No.	Type		No.	Type	
171	exe	Main RAM Faulty	176	-	-
172	exe	Main PROM Faulty	177	-	-
173	exe	Microwave Board Error	178	-	-
174	exe	Attenuator Type Unknown	179	-	-
175	exe	Wrong Attenuator fitted	180	-	-

Chapter 3-2
GPIB OPERATION

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INTRODUCTION

The 2030 Series signal generators can be operated remotely from a personal computer fitted with a GPIB interface card or a dedicated GPIB controller. All functions can be controlled by coded messages sent over the interface bus via the 24 way socket on the rear panel of the instrument. IEEE Standard 488.2 (1987) is implemented, which defines the protocols and syntax of commands.

The instrument can function either as a talker or a listener. In the listen mode, it will respond to IEEE 488.2 common commands and queries and device-specific commands and queries. These allow various device functions to be controlled and operating parameters to be set. In the talk mode, device status information and parameter settings can be read from the instrument.

For full information on the IEEE protocols and syntax the IEEE 488.2 Standard should be consulted.

GPIB FUNCTIONS

The IEEE 488.1 interface functions offered by 2030 Series are as follows:

Source handshake (SH1)	complete capability.
Acceptor handshake (AH1)	complete capability.
Talker (T6)	basic talker, serial poll, unaddress if MLA.
Listener (L4)	basic listener, unaddress if MTA.
Service Request (SR1)	complete capability.
Remote/Local (RL1)	complete capability.
Device clear (DC1)	complete capability.
Device trigger (DT1)	complete capability
Parallel Poll (PP0)	no capability.
Controller (C0)	no capability.
Tri-state drivers (E2)	as opposed to open collector drivers.

DEVICE LISTENING ELEMENTS

The following is a list of the device listening elements (as defined in the IEEE 488.2 standard) which are used in the 2030 Series of signal generators:

<PROGRAM MESSAGE>
<PROGRAM MESSAGE TERMINATOR>
<PROGRAM MESSAGE UNIT>
<PROGRAM MESSAGE UNIT SEPARATOR>
<COMMAND MESSAGE UNIT>
<QUERY MESSAGE UNIT>
<COMPOUND COMMAND PROGRAM HEADER>
<COMPOUND QUERY PROGRAM HEADER>
<PROGRAM HEADER SEPARATOR>
<PROGRAM DATA>
<PROGRAM DATA SEPARATOR>
<DECIMAL NUMERIC PROGRAM DATA>
<CHARACTER PROGRAM DATA>
<SUFFIX PROGRAM DATA>
<STRING PROGRAM DATA>
<ARBITRARY BLOCK PROGRAM DATA>

DEVICE TALKING ELEMENTS

The following is a list of the device talking elements (as defined in the IEEE 488.2 standard) which are used in the 2030 Series of signal generators:

<RESPONSE MESSAGE>
<RESPONSE MESSAGE TERMINATOR>
<RESPONSE MESSAGE UNIT>
<RESPONSE MESSAGE UNIT SEPARATOR>
<COMPOUND RESPONSE HEADER>
<RESPONSE HEADER SEPARATOR>
<RESPONSE DATA>
<RESPONSE DATA SEPARATOR>
<NR1 NUMERIC RESPONSE DATA>
<NR2 NUMERIC RESPONSE DATA>
<ARBITRARY ASCII RESPONSE DATA>
<CHARACTER RESPONSE DATA>
<STRING RESPONSE DATA>
<DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA>

PROGRAMMING

Program messages

A message consists of one or more message units. Message units are separated by a semi-colon (;). The whole message is ended by the Program Message Terminator (or End Of Message) defined as one of the following:

(1) <newline> (ASCII 10 - often known as 'line feed') or
(2) <newline> + END (the EOI line is asserted as well) or
(3) + END (EOI is asserted in the last data byte of the message)

Note...

A response message is always terminated by <EOM> consisting of <newline> + END.

A message unit consists of a mnemonic header which may be followed by data. If data follows, then it must be separated from its header by at least one space

<header><SPACE><data>
e.g. RFLV:INC 6.0 dB

Spaces may be freely inserted in a message to improve readability, except within a header or within data.

A header may be a command or a query. A query has a '?' as its final character and causes the generation of a response message which will be read by the controller. Common commands and queries (defined in IEEE 488.2) begin with a '*'.

Upper and lower case characters are considered equivalent (i.e. FM fm Fm fM are all interpreted by the 2030 Series in the same way).

Compound headers

The 2030 Series implements compound headers which allow a complex set of commands to be built up from a small set of basic elements in a 'tree and branch' structure. The elements of a compound header are separated by a colon (:). Spaces are not allowed within a header.

Special rules apply when more than one compound header is used in one message. When the separator ';' is encountered, all headers except the trailing element of the previous header in the message are assumed to precede the following header, for example:

AM:DEPTH 30PCT;ON

is equivalent to the two commands:

AM:DEPTH 30PCT
and AM:ON

This does not apply to common commands (*RST etc.). The rule may be overridden by preceding a header with a colon, for example:

AM:ON;:FM:ON

Most main functions have a short form of header which may be used for clarity and brevity in simple messages, for example:

CFRQ 1.25GHZ is the same as CFRQ:VALUE 1.25GHZ

Program data

Data can take many forms, as follows:

Decimal Numeric Data is a flexible numeric format which encompasses integer, fixed point and floating point (mantissa and exponent) representations. Data is rounded to a resolution appropriate to the function. Decimal data can, in most cases, be followed by the appropriate units. If no units are present, the specified default units are assumed.

Character Data is an alphanumeric word.

String Data consists of a number of 7-bit ASCII characters enclosed in quotes, either a pair of single ('ASCII 39') or double ("ASCII 34") quotes may be used.

Block Data is used by *PUD and allows a number of 8-bit bytes to be transferred. For further information see the Service Manual.

Some commands can accept Multiple Data items which are separated by commas, for example MODE FM,AM.

Message exchange protocol

The controller should not attempt to read a response until it has sent the entire query message (terminated by EOM). Also, it should not start to send a new message until it has read the entire response (terminated by EOM). The query message may contain more than one query message unit, but only one response message (containing several response message units) is generated.

Failure to follow the protocol will generate a query error:

UNTERMINATED (error 116) occurs when the controller attempts to read a response without having sent a query.

INTERRUPTED (error 117) occurs when the controller starts to send a new message before having read the response to a preceding query.

DEADLOCK (error 118) can only occur if the input and output buffers are both filled by the controller having sent an extra long Message containing several query message units.

The 2030 Series have input buffer stores of 256 characters and an output buffer of two response message units.

Remote/local operation

When the 2030 Series Signal Generator is addressed by the controller it will enter its remote mode and the screen will have only one key legend, *[LOCAL]*. Pressing this key returns the unit to normal manual operation, unless Local Lockout has been asserted by the controller.

Common commands and queries (IEEE 488.2)

The IEEE 488.2 standard defines a set of common commands and queries which implement common system functions.

Common command and query mnemonics are preceded by an asterisk (*) to distinguish them from device dependent data such as instrument programming strings. The following common commands and queries are implemented in the 2030 Series:

Mnemonic	Name and Description
*IDN?	Identification Query. Returns an arbitrary ASCII response comprising four data fields in the format: <Manufacturer>,<type number>,<serial number>,<firmware version number><EOM>.
Example:	`MARCONI INSTRUMENTS,2031,123456789,2.001<EOM>`
*OPT?	Option Identification Query. Returns an arbitrary ASCII response containing a data field for each fitted option in the format: <option a>,<option d>, ... ,<option *n*><EOM> If no options are fitted, ASCII '0' is returned.
Example:	`SECOND OSCILLATOR,PULSE MODULATION,+19 dBm OUTPUT<EOM>`

Note...

Because an Arbitrary ASCII Response ends with the Response Message Terminator (<EOM>) either *IDN? or *OPT? must be the last Query Message Unit in a Program Message.

*RST	Reset Command. Sets the instrument functions to the factory default power up state. The default settings appear in Table 3-2-1.
*TST?	Self Test Query. Returns a '0' when the GPIB interface and processor are operating.
*OPC	Operation Complete Command. Sets the Operation Complete bit in the Standard Event Status Register when execution of the preceding operation is complete.
*OPC?	Operation Complete Query. Returns a '1' when the preceding operation has been completed.
*WAI	Wait to Continue Command. Inhibits execution of an overlapped command until the execution of the preceding operation has been completed.
*TRG	Trigger Command. Equivalent to Group Execute Trigger.
*PUD <block>	Protected User Data Command. Sets the Protected User Data, accepts Definite Block Data when enabled. This command is covered in further detail in the Service Manual.
*PUD?	Protected User Data Query. Returns the User Data as a Definite Block Response.
Example:	`#221Inventory Number 1234`
*STB?	Read Status Byte Query. Returns the value of the Status Byte as an nr1 number (0-255).

*SRE <nrf>	Service Request Enable Command. Sets the Service Request Enable Register.
*SRE?	Service Request Enable Query. Returns the value of the Service Request Enable Register as nr1.
*ESR?	Standard Event Status Register Query. Returns the value of the Status Event Status Register as nr1.
*ESE <nrf>	Standard Event Status Enable Command. Sets the Standard Event Enable Register.
*ESE?	Standard Event Status Enable Query. Returns the value of the Standard Event Status Enable Register as nr1.
*CLS	Clear Status Command. Clears all the Status Event registers and clears the Error Queue. Does not affect the Enable Registers.

Note...

The IEEE 488.2 Device Clear function only affects the GPIB functions. The input and output buffers are cleared and the instrument put into a state to accept new Messages. It no longer puts the instrument functions into a defined state, this is now performed by the *RST common command.

DEVICE DEPENDENT COMMANDS

The following list describes the features of the device dependent mnemonics for the 2030 Series signal generators together with simple examples of their use within each major section (Carrier frequency, RF level, etc.) the root mnemonic is listed first followed by the lower level mnemonics. Each group is followed by a list of requirements for data type and suffix.

In addition to the normal listen commands the 2030 Series accept query commands which cause the instrument to prepare a message which will be sent to the controller when the instrument is next addressed to talk. For each query an example of a response is given. Where responses are similar for a group of queries not all are listed. Some queries can produce more than one type of response - an example of each is usually given.

In the list which follows, the abbreviations <char>, <nrf> and <str> have the following meanings:

<char> = Character Program Data
<nrf> = Decimal Numeric Program Data
<str> = String Program Data

Where the data format is Decimal Numeric Program Data, the value may be expressed as a signed or unsigned number in any of the following formats:

nr1: Decimal integer, e.g. 1234 or -567
nr2: Floating point number, e.g. 1.234 or -56.789
nr3: Floating point number with exponent, e.g. 1.2345E5 or -12.47E-8

DEFAULT SETTINGS

These are the settings assigned to instrument functions in the following cases:

(i) Power-up to factory default settings.

(ii) Execution of *RST command.

(iii) Recall Full Store 50.

The instrument functions set to the factory default power-up state by the reset command (*RST) are as shown in Table 3-2-1.

TABLE 3-2-1 INSTRUMENT DEFAULT SETTINGS

Instrument Mode	:	Normal
Carrier Frequency	:	(Maximum available) 1.35 GHz/2.7 GHz/5.4 GHz
Step	:	1 kHz
RF Level	:	-144 dBm
Step	:	1 dB Status: ON
Modulation Mode	:	Single FM , Modulation enabled

TABLE 3-2-1 INSTRUMENT DEFAULT SETTINGS (continued)

Modulations	:	FM1 : 0 Hz, Int F4, ON
		FM2 : 0 Hz, Ext 1 ALC, ON
		ΦM1 : 0 rad, Int F4, ON
		ΦM2 : 0 rad, Ext 1 ALC, ON
		AM1 : 0%, Int F4, ON
		AM2 : 0%, Ext 2 ALC, ON
		WBFM : (Minimum setting), AC coupled, ON
Steps	:	ΔFM 1 kHz, Δ ΦM 0.1 rad, ΔAM 1%
Modulation source	:	IntF1 : 300 Hz sine
		IntF2 : 400 Hz sine
		IntF3 : 500 Hz sine
		IntF4 : 1 kHz sine
		IntF5 : 3 kHz sine
		IntF6 : 6 kHz sine
Step	:	1 kHz
LF	:	Mode : Monitor, Mod Source
LF Generator	:	Frequency : 1 kHz sine, step 1 kHz
		Level : 100 μV
		Step : 1 dB
		Status : ON
Sweep:		
Type	:	RF Level
Mode	:	Single Internal
RF Level Sweep	:	
Start	:	–144 dBm Stop: 10 dBm Steps: 100 Time: 50 ms
Markers	:	2, 4, 6, 8, 10 dBm, disabled
Carrier Freq. Sweep	:	
Start	:	100 MHz Stop: (Maximum available) Steps: 250 Time 50 ms
Markers	:	200, 400, 600, 800, 1000 MHz, disabled
Mod. source Freq.	:	
Start	:	0.1 Hz Stop: 500 kHz Steps: 10,000 Time: 500 ms
Markers	:	100, 20, 30, 400, 500 kHz
Sequential Tones	:	
Mode	:	No modulation selected
Standard	:	CCIR
Sequence	:	16 tone Fs
Duration	:	All normal
Frequency Offset	:	0
Extended Duration	:	500 ms
Repeat Tone	:	E
Start Delay	:	200 ms

INSTRUMENT MODE

IMODE Select instrument mode

Data type : Character Program Data (either NORMAL for signal generator operation or SWEEPER for swept operation)
Allowed suffices : None
Default suffix : None

Example: `IMODE NORMAL`

CARRIER FREQUENCY

CFRQ Set Carrier Frequency (short form)
:VALUE Set Carrier Frequency
:INC Set Carrier Frequency step

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:UP Go UP one step
:DN Go DOWN one step
:RET Return to original setting
:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

:PHASE Adjust Phase of Carrier in steps of π/128 radians (approximately 1.4°) over a range of ±255 steps

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

Examples:
```
CFRQ:VALUE 1.23MHZ;INC 10KHZ
CFRQ:UP;XFER
```

CFRQ? Prepares message containing information on Carrier Frequency setting in the following format:

:CFRQ:VALUE <nr2>; INC <nr2>

Example: `:CFRQ:VALUE 1000000000.0;INC 25000.0`

RF LEVEL

RFLV Set RF output level (short form)

:VALUE Set RF output level

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: DBM, DBV, DBMV, DBUV, V, MV or UV
Default suffix : dBm unless changed by UNITS command

:INC Set RF level step (dB)

Data type : Decimal Numeric Program Data
Allowed suffices : DB only
Default suffix : DB

:UP Go UP one step
:DN Go DOWN one step
:RETN Return to original setting
:XFER Transfer current value to be the new setting
:ON Turn RF output ON
:OFF Turn RF output OFF

Data type : None
Allowed suffices : None
Default suffix : None

:TYPE Selects EMF or PD for voltage related units

Data type : Character Program Data (EMF or PD)
Allowed suffices : None
Default suffix : None

:UNITS Select default RF level units.

Data type : Character Program Data (DBM, DBV, DBMV, DBUV, V, MV or UV)
Allowed suffices : None
Default suffix : None

Examples:
```
RFLV:VALUE -27.3DBM;ON
RFLV:TYPE PD;VALUE 1.23UV
```

:OFFS [not used alone]

:VALUE Set Offset of current band

Data type : Decimal Numeric Program Data
Allowed suffices : DB only
Default suffix : DB

:ON Turn ON offset of current band
:OFF Turn OFF offset of current band
:ENABLE Enable Offsets
:DISABLE Disable Offsets
:SAVE Store Offsets in memory

Data type : None
Allowed suffices : None
Default suffix : None

Example: `RFLV:OFFS:VALUE -0.2DB;ON;ENABLE`

RFLV?

Prepares message containing information on RF Level setting in the following format:

:RFLV:UNITS <unit>;TYPE <type>;VALUE <nr2>;INC <nr2>;<status>

where: <unit> is character program data defining the default RF level units (DBM, DBV, DBMV, DBUV, V, MV or UV), <type> is character program data indicating EMF or PD and <status> is a program mnemonic indicating whether the RF output is ON or OFF.

Examples:
```
:RFLV:UNITS DBM;VALUE -103.5;INC 2.0;ON
:RFLV:UNITS DBV;TYPE EMF;VALUE -83.2;INC 0.5;ON
```

RFLV:OFFS?

Prepares message containing information on RF Level offsets in the following format:

:CFRQ:VALUE <nr2>;:RFLV:OFFS:VALUE <nr2>;<status>;<activity>

where: <status> is a program mnemonic indicating whether the RF offset is ON or OFF and <activity> is a program mnemonic indicating whether the offset mode is enabled or disabled.

Example: `:CFRQ:VALUE 500000000.0;:RFLV:OFFS:VALUE -0.4;ON;ENABLE`

RFLV

:HYST [not used alone]
:ENABLE Enable Extended Hysteresis mode
:DISABLE Disable Extended Hysteresis mode

Data type : None
Allowed suffices : None
Default suffix : None

:RFLV:HYST? Responds with status as follows:

:RFLV:HYST:ENABLE
or :RFLV:HYST:DISABLE

RFLV

:LIMIT Set RF output level limit (short form)
:VALUE Set RF output level limit

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of DBM, DBV, DBMV, DBUV, V, MV or UV
Default suffix : dBm unless changed by UNITS command (see above).

:ENABLE Enable RF output level limit
:DISABLE Disable RF output level limit
:SAVE Save RF output level limit to memory

Data type : None
Allowed suffices : None
Default suffix : None

RFLV:LIMIT? Prepares message containing information on RF level setting in the following format:

:RFLV:UNITS <unit>;TYPE <type>;LIMIT:VALUE<nr2>;<status>

where: <unit> is character program data defining the default RF level units (DBM, DBV, DBMV, DBUV, V, MV or UV), <type> is character program data indicating EMF or PD and <status> is a program mnemonic indicating whether the RF level limit is enabled or disabled.

Examples:
```
:RFLV:UNITS DBM;LIMIT:VALUE -10.2;ENABLE
:RFLV:UNITS V;TYPE PD;LIMIT:VALUE 0.224;DISABLE
```

MODULATION MODE

MODE Set modulation mode

Data type : Character Program Data (valid combinations of AM, AM1, AM2, FM, FM1, FM2, PM, PM1, PM2, WBFM or PULSE, see Table below)

Allowed suffices : None

Default suffix : None

Examples:
```
MODE AM,FM
MODE FM1,FM2
```

VALID MODE COMBINATIONS TABLE

Single	Composite	Dual	Dual Composite
AM1	AM1,AM2	AM1,FM1	AM1,AM2,FM1,FM2
FM1	FM1,FM2	AM1,PM1	AM1,AM2,PM1,PM2
PM1	PM1,PM2	AM1,WBFM	AM1,AM2,WBFM
WBFM		PULSE,FM1	PULSE,FM1,FM2
PULSE		PULSE,PM1	PULSE,PM1,PM2
		PULSE,WBFM	

Note...

At any time the '1' may be omitted, for example FM is equivalent to FM1. Order is not important, for example AM,FM is equivalent to FM,AM.

For instruments without pulse modulation (Option 002) fitted, select Low Intermodulation mode by using character data type PULSE.

MODE? Prepares message containing information on Modulation Mode in the following format:

:MODE:<mode>

where: <mode> is character program data indicating the modulation mode settings.

Example:
```
:MODE FM1,FM2
```

MODULATION CONTROL

MOD [not used alone]

:ON Turn modulation globally ON

:OFF Turn modulation globally OFF

Examples:
```
MOD:ON
MOD:OFF
```

MOD? Prepares message containing information on Modulation Control in the following format:

:MOD:<status>

where: <status> is a program mnemonic indicating whether the Modulation is globally ON or OFF.

Example:
```
:MOD:ON
```

FREQUENCY MODULATION

FM or FM1 or FM2 — Set FM deviation (short form)

:DEVN — Set FM deviation

:INC — Set FM step size

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:<src> — Select modulation source where <src> is any one of: INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, EXT1DC, EXT1AC, EXT1ALC, EXT2DC, EXT2AC or EXT2ALC

:ON — Turn FM ON (locally)

:OFF — Turn FM OFF (locally)

:UP — Go UP one step

:DN — Go DOWN one step

:RETN — Return to original setting

:XFER — Transfer current value to be the new setting

DCFMNL — Perform DC FM/WBFM null operation

Data type : None
Allowed suffices : None
Default suffix : None

Examples:

```
FM:DEVN 25KHZ;INTF4;ON
FM1:DEVN 15KHZ;INC 1KHZ;EXT1DC
DCFMNL
```

FM? or FM1? or FM2? — Prepares message containing information on FM setting in one of the following formats:

:FM:DEVN <nr2>;<src>;<status>;INC <nr2>
:FM1:DEVN <nr2>;<src>;<status>;INC <nr2>
:FM2:DEVN <nr2>;<src>;<status>;INC <nr2>

where: <src> is a program mnemonic representing the source of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF

Example:

```
:FM1:DEVN 25000.0;INTF1;ON;INC 1000.0
```

PHASE MODULATION

PM or PM1 or PM2 Set Phase deviation (short form)

:DEVN Set Phase deviation

:INC Set Phase Modulation step size

Data type : Decimal Numeric Program Data
Allowed suffices : RAD or RADS
Default suffix : RAD

:<src> Select modulation source where <src> is any one of: INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, EXT1DC, EXT1AC, EXT1ALC, EXT2DC, EXT2AC or EXT2ALC

:ON Turn PM ON (local)

:OFF Turn PM OFF (local)

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
PM:DEVN 2.5RAD;INTF4;ON
PM1:DEVN 1.5RAD;INC 0.1RAD;EXT1AC
```

PM? or PM1? or PM2? Prepares message containing information on Phase Modulation setting in one of the following formats:

:PM:DEVN <nr2>;<src>;<status>;INC <nr2>
:PM1:DEVN <nr2>;<src>;<status>;INC <nr2>
:PM2:DEVN <nr2>;<src>;<status>;INC <nr2>

where <src> is a program mnemonic representing the source of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF

Example:
```
:PM2:DEVN 2.30;INTF4;OFF;INC 0.05
```

AMPLITUDE MODULATION

AM or AM1 or AM2 — Set AM Depth (short form)

:DEPTH — Set AM Depth

:INC — Set AM step size

Data type : Decimal Numeric Program Data
Allowed suffices : PCT
Default suffix : PCT

:<src> — Select modulation source where <src> is any one of: INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, EXT1DC, EXT1AC, EXT1ALC, EXT2DC, EXT2AC or EXT2ALC

:ON — Turn AM ON (local)

:OFF — Turn AM OFF (local)

:UP — Go UP one step

:DN — Go DOWN one step

:RETN — Return to original setting

:XFER — Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Examples:

```
AM:DEPTH 30PCT;INTF4;ON
AM1:DEPTH 40PCT;EXT1DC;ON
```

AM? or AM1? or AM2? — Prepares message containing information on Amplitude Modulation setting in one of the following formats:

:AM:DEPTH <nr2>;<src>;<status>;INC <nr2>
:AM1:DEPTH <nr2>;<src>;<status>;INC <nr2>
:AM2:DEPTH <nr2>;<src>;<status>;INC <nr2>

where <src> is a program mnemonic representing the source of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF

Example:

```
:AM1:DEPTH 56.6;INTF3;ON;INC 5.0
```

WIDEBAND FM

WBFM Set WBFM deviation (short form)

:DEVN Set WBFM deviation

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:ON Turn WBFM ON (local)
:OFF Turn WBFM OFF (local)
:AC Select AC coupling
:DC Select DC coupling

Data type : None
Allowed suffices : None
Default suffix : None

DCFMNL Perform DC FM/WBFM null operation

Examples:
```
WBFM:DEVN 10MHZ;ON;AC
WBFM:DEVN 13MHZ;ON;DC;:DCFMNL
```

WBFM? Prepares message containing information on Wideband Frequency Modulation setting in the following format:

:WBFM:DEVN <nr2>;<coupling>;<status>

where <coupling> is a program mnemonic indicating AC or DC coupling of the modulation signal and <status> is a program mnemonic indicating whether the modulation is locally ON or OFF

Example:
```
:WBFM:DEVN 500000.0;AC;ON
```

PULSE MODULATION

PULSE [not used alone]
:ON Turn Pulse modulation ON
:OFF Turn Pulse modulation OFF and select Low Intermodulation
:CAL:ENABLE Enable CW burst suppression mode
:DISABLE Disable CW burst suppression mode

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
PULSE:ON
PULSE:OFF
PULSE:CAL:DISABLE
```

PULSE?

Prepares message containing information on Pulse Modulation setting in the following format:

:PULSE:<status>

where: <status> is a program mnemonic indicating whether the modulation is ON or OFF

Examples:
```
:PULSE:ON
:PULSE:OFF
```

PULSE:CAL?

Prepares message containing information on CW Burst Suppression mode in the following format:

:PULSE:CAL:<status>

where: <status> is a program mnemonic indicating whether CW burst suppression mode is ENABLED or DISABLED

Example:
```
:PULSE:CAL:ENABLE
```

MODULATION FREQUENCY

INTF1 or INTF2 or INTF3 or INTF4 or INTF5 or INTF6 Set modulation oscillator frequency (short form)

:FREQ Set modulation oscillator frequency

:INC Set modulation oscillator frequency step size

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:SIN Select sinusoidal waveform

:TRI Select triangle wave

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

:PHASE Adjust phase of modulation oscillator

Data type : Decimal Numeric Program Data
Allowed suffices : DEG
Default suffix : DEG

:CTC1 Select tone number (0 to 15) from Continuous Tone Group 1

:CTC2 Select tone number (0 to 15) from Continuous Tone Group 2

:USER Select tone number (0 to 15) from Continuous Tone USER group

:TEMP Select tone number (0 to 15) from Continuous Tone TEMP group

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

Examples:
```
INTF1:FREQ 1.5KHZ;SIN
INTF1:CTC1 3
```

INTF1? or INTF2? or INTF3? or INTF4? or INTF5? or INTF6?

Prepares message containing information on modulation oscillator setting in one of the following formats:

:INTF1:FREQ <nr2>;INC <nr2>;<waveform>
:INTF6:<standard> <nr1>

where: <waveform> is a program mnemonic (SIN or TRI) indicating the waveform shape and <standard> is a program mnemonic (CTC1, CTC2, USER or TEMP) indicating the continuous tone signalling standard selected.

Examples:
```
:INTF2:FREQ 440.0;INC 100.0;SIN
:INTF3:CTC1 5
```

CTCSS TONES EDIT

CTONES [not used alone]

:EDIT [not used alone]

:TNUM Select tone number 0-15

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:TFRQ Set tone frequency

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:LOAD Copy Standard to TEMP for editing

Data type : Character Program Data (any one of: CTC1, CTC2 or USER)
Allowed suffices : None
Default suffix : None

:SAVE Save TEMP to USER after editing for non-volatile storage (if required)

Data type : None
Allowed suffices : None
Default suffix : None

CTONES? [not used alone]

CTONES:EDIT? Prepares message containing information on the current tone number being edited and its frequency in the following format:

:CTONES:EDIT:TNUM <nr1>;TFRQ <nr2>

Example: `:CTONES:EDIT:TNUM 5;TFRQ 202.8`

SEQUENTIAL TONES

SEQT [not used alone]

:SEQ Set Tone sequence

Data type : String Program Data consisting of up to 16 characters from 0 to 9 and A to F between string delimiters (eg. "123C5" or '123C5'). For DTMF E and F are not allowed and are replaced by * and #.
Allowed suffices : None
Default suffix : None

:DUR Set Duration Mask

Data type : String Program Data consisting of up to 15 characters "-" or "E" between string delimiters (eg. "---E-" or '---E-')
Allowed suffices : None
Default suffix : None

:SEND Send Sequence *n* times where *n* has the value 1 to 9 indicating the number of tone sequences to be sent.

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:STOP Stop sending sequence.

Data type : None
Allowed suffices : None
Default suffix : None

:MODE [not used alone]

:STD Select Tones standard

Data type : Character Program Data (any one of: CCIR, EURO, DZVEI, ZVEI1, ZVEI2, EEA, EIA, NATEL, TEMP, USER1, USER2 or DTMF).
Allowed suffices : None
Default suffix : None

:MOD Select Modulation Channel

Data type : Character Program Data (any one of: AM1, AM2, FM1, FM2, PM1, PM2, TOTAL_AM, TOTAL_FM, TOTAL_PM or NO_TONES)
Allowed suffices : None
Default suffix : None

:PARAM [not used alone]

:EXTD Set the duration of the Extended tone.

:SDLY Set Starting Delay

Data type : Decimal Numeric Program Data
Allowed suffices : MS
Default suffix : MS

:SHFT Set Frequency Shift (up to ±10.0%)
Data type : Decimal Numeric Program Data
Allowed suffices : PCT
Default suffix : PCT

:RPTT Select Repeat Tone

Data type : String Program Data (any one of 0 to 9 or A to F between strings delimiters (eg. "E" or 'E').
Allowed suffices : None
Default suffix : None

:TDUR Set DTMF Tone duration

:TGAP Set DTMF inter-element gap

Data type : Decimal Numeric Program Data
Allowed suffices : MS
Default suffix : MS

:EDIT [not used alone]

:TNUM Select Number of Tone to Edit

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:TFRQ Set Tone Frequency of tone selected by TNUM

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:TDUR Set Normal Tone Duration

:TGAP Set Inter-element Gap

Data type : Decimal Numeric Program Data
Allowed suffices : MS
Default suffix : MS

:LOAD Load a Standard to TEMP for editing

Data type : Character Program Data (any one of: CCIR, EURO, DZVEI, ZVEI1, ZVEI2, EEA, EIA, NATEL, USER1 or USER2)
Allowed suffices : None
Default suffix : None

:SAVE Copy TEMP to USER1 or USER2

Data type : Character Program Data (either USER1 or USER2)
Allowed suffices : None
Default suffix : None

Examples:
```
SEQT:SEQ "12245B7";DUR "----E--"
SEQT:MODE STD CCIR;MOD TOTAL_FM
SEQT:PARAM:EXTD 200MS;SHFT 0.5PCT
SEQT:EDIT:TNUM 3;TFRQ 1342.7HZ;SAVE USER1
```

SEQT?

Prepares message containing information on the signalling sequence and duration settings in the following format:

:SEQT:SEQ <toneseq>;DUR <durseq>

where: <toneseq> is string program data defining the tone sequence and <durseq> is string program data defining the duration sequence.

Examples:
```
:SEQT:SEQ "12245B7";DUR "----E--"
:SEQT:SEQ "12345*#9"          (DTMF ONLY)
```

SEQT:MODE?

Prepares message containing information on the signalling standard and the modulation channel selected in the following format:

:SEQT:MODE:STD <standard>;MOD <modchannel>

where: <standard> is a program mnemonic defining the tone standard and <modchannel> is character program data defining the modulation channel allocated to tone signalling.

Example:
```
:SEQT:MODE:STD ZVEI;MOD TOTAL_FM
```

SEQT:PARAM?

Prepares message containing information on signalling parameter settings in the following format:

:SEQT:PARAM:EXTD <nr1>;SHFT <nr2>;RPTT <rpt>;SDLY <nr1>

where: <rpt> is string program data defining the tone number used to represent the repeat tone.

Examples:
```
:SEQT:PARAM:EXTD 200;SHFT -1.6;RPTT "E";SDLY 300
:SEQT:PARAM:SDLY 30;TDUR 100;TGAP 75        (DTMF ONLY)
```

SEQT:EDIT?

Prepares message containing information on signalling editing in the following format:

:SEQT:EDIT:TNUM <nr1>;TFREQ <nr2>;TDUR <nr1>;TGAP <nr1>

Example: `:SEQT:EDIT:TNUM 3;TFREQ 1342.7;TDUR 40;TGAP 0`

LF CONTROL

LF [not used alone]

:ON Turn LF output ON

:OFF Turn LF output OFF

:GEN Select LF Generator

Data type : None
Allowed suffices : None
Default suffix : None

:MON Select source monitor mode

Data type : Character Program Data (any one of: AM1S, AM2S, AMD, ANG1S, ANG2S, ANGD or OFF, where AM represents Amplitude Modulation, ANG represents Angular Modulation, the suffix 'S' indicates Source and 'D' indicates Drive)
Allowed suffices : None
Default suffix : None

Examples:
```
LF:MON FM;ON
LF:MON ANGD
LF:GEN
```

LF? Prepares message containing information on the LF operation in one of the following formats depending on which LF mode is currently in use:

:LF:GEN;<status>
:LF:MON <source>;<status>

where: <source> is character program data representing the source being monitored and <status> is a program mnemonic indicating whether the output is ON or OFF.

Examples:
```
:LF:GEN;ON
:LF:MON AM1S;OFF
```

LF GENERATOR FREQUENCY

LFGF Set LF Generator frequency (short form)

:VALUE Set LF Generator frequency

:INC Set LF Generator frequency step

Data type : Decimal Numeric Program Data
Allowed suffices : Any one of: GHZ, MHZ, KHZ or HZ
Default suffix : HZ

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

:SIN Select sinusoidal waveform

:TRI Select triangle wave

Data type : None
Allowed suffices : None
Default suffix : None

Example: `LFGF:VALUE 25KHZ;INC 500HZ`

LFGF? Prepares message containing information on LF Generator Frequency setting in the following format:

:LFGF:VALUE <nr2>;INC <nr2>

Example: `:LFGF:VALUE 25067.8;INC 500.0`

LF GENERATOR LEVEL

LFGL Set LF Generator level (short form)

:VALUE Set LF Generator level

Data type : Decimal Numeric Program Data
Allowed suffices : V, MV, UV, DBMV
Default suffix : V

:INC Set LF Generator level step

Data type : Decimal Numeric Program Data
Allowed suffices : DB
Default suffix : DB

:UP Go UP one step
:DN Go DOWN one step
:RETN Return to original setting
:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

:UNITS Select default LF level units

Data type : Character Program Data (DBM, DBV, DBMV, V, MV, or UV)
Allowed suffices : None
Default suffix : None

Examples:

```
LFGL:VALUE 75.6MV;INC 20DB

LFGL:UP
```

LFGL? Prepares the message containing information on LF Generator Level setting in the following format:

:LFGL:UNITS<unit>;VALUE<nr2>;INC<nr2>

where: <unit> is character programmed data defining the default LF level units (DBM, DBV, DBMV, V, MV or UV).

Example:

```
:LFGL:UNITS MV;VALUE 125.8;INC 1.0
```

MEMORY - STORE

STO	[not used alone]
:FULL	Full Store 0-49
:PART	Partial Store 0-49
:CFRQ	Carrier Freq Store 0-99
:SEQT	Sequential Tones Store 0-19
:SWEEP	Sweep Store 0-19

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

Examples:
```
:STO:FULL 17
:STO:CFRQ 83
```

MEMORY - RECALL

RCL	[not used alone]
:FULL	Recall Full 0-49
:FXCF	Recall Full 0-49 (without carrier frequency)
:PART	Recall Partial 0-49
:PXCF	Recall Partial 0-49 (without carrier frequency)
:CFRQ	Recall Carrier Freq 0-99
:SEQT	Recall Sequential Tones Sequence 0-19
:SWEEP	Recall Sweep 0-19

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

Examples:
```
:RCL:FULL 15
:RCL:CFRQ 75
```

MEMORY - ERASE

ERASE	[not used alone]
:FULL	Erase all Full Stores
:PART	Erase all Partial Stores
:CFRQ	Erase all Carrier Freq Stores
:SEQT	Erase all Sequential Tones Stores
:SWEEP	Erase all Sweep Stores
:ALL	Erase all Stores

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
:ERASE:FULL 12
:ERASE:ALL
```

SWEEP OPERATION

IMODE Select Instrument Mode

Data type : Character Program Data (either NORMAL for signal generator operation or SWEEPER for swept operation)
Allowed suffices : None
Default suffix : None

Example:
```
IMODE SWEEPER
```

SWEEP [not used alone]

:MKRON Enable Sweep Markers
:MKROFF Disable sweep Markers

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
SWEEP:CFRQ:START 75MHZ;STOP 150MHZ;STEP 100;TIME 10MS
SWEEP:RFLV:START -56DBM;STOP -12DBM;STEP 440;TIME 25MS
SWEEP:CFRQ:MKRNUM 1;VALUE 83MHZ;MKRON
```

:CFRQ [not used alone]
:<cmd> Select Carrier Frequency sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:RFLV [not used alone]
:<cmd> Select RF Level sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:LFGF [not used alone]
:<cmd> Select LF Generator Frequency sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:LFGL [not used alone]
:<cmd> Select LF Generator Level sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

:INTF [not used alone]
:<cmd> Select Internal Modulation Oscillator Frequency sweep parameter entry where <cmd> is replaced by one of the commands (START, STOP, STEP, TIME, MKRNUM, MKRON, MKROFF or VALUE)

HOP [not used alone]
:<cmd> Select Frequency Hopping sweep parameter entry where <cmd> is replaced by TIME.

SWEEP? (continued)

:START Select start value of the parameter to be swept.
:STOP Select stop value of the parameter to be swept.

Data type : As used for the parameter
Allowed suffices : As used for the parameter
Default suffix : As used for the parameter

:STEP Select number of steps in the sweep.

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:TIME Select time per sweep step

Data type : Decimal Numeric Program Data
Allowed suffices : MS
Default suffix : MS

:MKRNUM Select marker

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:MKROFF Turn Current Marker OFF
:MKRON Turn Current Marker ON

Data type : None
Allowed suffices : None
Default suffix : None

:VALUE Set Value of Current Marker

Data type : Decimal Numeric Program Data
Allowed suffices : As used for the parameter
Default suffix : As used for the parameter

SWEEP? Prepares message containing information on Sweep Mode, Type and Marker status in the following format:

:SWEEP:MODE <mode>;TYPE <type>;<status>

where: <mode> is a program mnemonic representing the sweep mode selected, <type> is a program mnemonic representing the sweep type selected and <status> is a program mnemonic indicating whether the Marker output is ON or OFF.

Sample responses:
```
:SWEEP:MODE CONT;TYPE CFRQ;MKROFF
:SWEEP:TYPE HOP:MODE SNGL
```

SWEEP? (continued)

:CFRQ?

Prepares message containing information on Carrier Frequency Sweep settings in the following format:

:SWEEP:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>; MKRNUM <nr1>;<status>;VALUE <nr2>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response:

```
:SWEEP:START 1230000.0;STOP 1330000.0;STEP 100;
TIME 20;MKRNUM 2;MKRON;VALUE 1240000.0
```

:RFLV?

Prepares message containing information on RF Level Sweep settings in the following format:

:SWEEP:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>; MKRNUM <nr1>;<status>;VALUE <nr2>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response:

```
:SWEEP:START -107.0;STOP -27.0;STEP 80;TIME 50;
MKRNUM 2;MKRON;VALUE -97.0
```

:LFGF?

Prepares message containing information on LF Generator Frequency Sweep settings in the following format:

:SWEEP:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>; MKRNUM <nr1>;<status>;VALUE <nr2>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response:

```
:SWEEP:START 300.0;STOP 3000.0;STEP 2700;TIME 1;
MKRNUM 1;MKRON;VALUE 400.0
```

SWEEP? (continued)

:LFGL?

Prepares message containing information on LF Generator Level Sweep settings in the following format:

:SWEEP:LFGL:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>; MKRNUM <nr1>;<status>;VALUE <nr2>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response:

```
:SWEEP:LFGL:START 1.0;STOP 120.0;STEP 120;TIME 10;
MKRNUM 2;MKRON;VALUE 5.0
```

:INTF?

Prepares message containing information on Modulation Oscillator Frequency Sweep settings in the following format:

:SWEEP:INTF:START <nr2>;STOP <nr2>;STEP <nr1>;TIME <nr1>; MKRNUM <nr1>;<status>;VALUE <nr2>

where: <status> is a program mnemonic indicating whether the selected Marker is ON or OFF.

Sample response:

```
:SWEEP:INTF:START 270.0;STOP 3300.0;STEP 500;TIME 1;
MKRNUM 4;MKRON;VALUE 2900.0
```

:HOP?

Prepares message containing information on Frequency Hopping Sweep in the following format:

:SWEEP:HOP:TIME<nr1>

SWEEP MODE/TYPE

SWEEP

[not used alone]

:MODE

Select Mode of operation for Sweep generator (single shot, continuous or externally triggered)

Data type : Character Program Data (any one of SNGL, CONT or EXT)
Allowed suffices : None
Default suffix : None

SWEEP? (continued)

:TYPE Select Type of Sweep (Carrier Frequency, RF Level, LF Generator Frequency, LF Generator Level, Internal Modulation Oscillator Frequency or Off)

Data type : Character Program Data (any one of: OFF, CFRQ, RFLV, LFGF, LFGL, INTF1, INTF2, INTF3, INTF4, INTF5, INTF6, HOP or OFF)
Allowed suffices : None
Default suffix : None

Examples:
```
:SWEEP:MODE SNGL;TYPE CFRQ
:SWEEP:MODE CONT;TYPE INTF4
```

SWEEP? Prepares message containing information on Sweep Mode, Type and Marker status in the following format:

:SWEEP:MODE <mode>;TYPE <type>;<status>

where: <mode> is a program mnemonic representing the sweep mode selected, <Type> is a program mnemonic representing the sweep type selected and <status> is a program mnemonic indicating whether the Marker output is ON or OFF.

Examples:
```
:SWEEP:MODE CONT;TYPE CFRQ;MKROFF
:SWEEP:TYPE HOP:MODE SNGL
```

SWEEP CONTROL

SWEEP [not used alone]
:GO Commence Sweep
:CALC Initiate Pre-calculation
:HALT Pause Sweep
:CONT Continue Sweep
:RESET Reset sweep to Start Value
:XFER Transfer Paused Value to Main Parameter
:UP Go UP one sweep step while paused
:DN Go DOWN one sweep step while paused

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
SWEEP:GO
SWEEP:RESET
```

FREQUENCY HOPPING

HOPSEQ Enter frequency hopping sequence

Data type : Decimal Numeric Program data (can be multiple)
Allowed suffices : None
Default suffix : None

Examples:
```
HOPSEQ 56, 72, 0, 4, 99, 72
HOPSEQ 255, 0, 4, 17, 23, 64, 72
```

HOPSEQ? Returns a value 0-1024 indicating the number of steps in the Frequency Hopping Sequence.

MISCELLANEOUS COMMANDS

IMODE Select Instrument Mode

Data type : Character Program Data (either NORMAL for signal generator operation or SWEEPER for swept operation)
Allowed suffices : None
Default suffix : None

RPPR Reset reverse power protection trip

Data type : None
Allowed suffices : None
Default suffix : None

FSTD Select internal or external frequency standard

Data type : Character program data (any one of INT0, INT1, INT5, INT10, EXT1, EXT5 or EXT10)
Allowed suffices : None
Default suffix : None

Examples:
```
:FSTD INT10
:FSTD EXT5
```

FSTD? Prepares message containing information on frequency standard selection in the format:

:FSTD <char>

Example:
```
:FSTD EXT10
```

BLANK Blank or unblank various parts of the display. The number sent after the command determines the action to be taken as follows:

0 blank or unblank the Carrier Frequency display
1 blank or unblank the RF Level display
2 blank or unblank the Modulation Frequency display
3 blank or unblank the Modulation display
4 blank all displays

Data type : Decimal Numeric Program Data (any one of 0, 1, 2, 3 or 4)
Allowed suffices : None
Default suffix : None

Examples:
```
BLANK 0
BLANK 4
```

BACKL [not used alone]
:ON Backlighting On
:OFF Backlighting Off

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
BACKL:ON
BACKL:OFF
```

TIME?

Prepares message containing information on current real time clock time setting in the format:

<HH:MM>

where: <HH:MM> is string program data representing the time in hours and minutes using the 24 hour clock notation.

Example:
```
"17:55"
```

DATE?

Prepares message containing information on current real time clock date setting in the format:

<YYYY-MM-DD>

where: <YYYY-MM-DD> is string program data representing the date in ISO notation (year number, month number, day number).

Example:
```
"1990-04-01"
```

OPER?

Prepares message containing information on total operating hours in the following format:

<nr2>

Example:
```
1453.0
```

ELAPSED?

Prepares message containing information on elapsed operating hours since last reset in the following format:

<nr2>

Example:
```
454.5
```

ERROR?

Prepares message containing the number of the next error in the error queue in the following format:

<nr1>

The numeric value returned is either that of the next error number or 0 if the queue is empty or 255 if the queue is full

Example: `37`

DEVTRG

Set Device Trigger Function (action on receipt of *TRG)

Data type : Character Program Data (any one of: SEQT, FLSWP, SSSWP or VOID)
Allowed suffices : None
Default suffix : None

EXTTRG

Set External Trigger Function (action on Low signal being applied to External Trigger Socket).

Data type : Character Program Data (any one of: SEQT, FLSWP, SSSWP, MEMUP, MEMDN or VOID)
Allowed suffices : None
Default suffix : None

Examples:
```
DEVTRG SEQT
EXTTRG MEMUP
```

KLOCK

Disables keyboard entry except RPP Reset and Go to Local

Data type : None
Allowed suffices : None
Default suffix : None

KUNLOCK

Enables keyboard entry

Data type : None
Allowed suffices : None
Default suffix : None

THE STATUS BYTE

The Status Byte provides information about events and conditions within the instrument. It may be read by a conventional Serial Poll or its value obtained as a response to the *STB? query. Bits 0 to 5 and bit 7 are each single bit Summary Messages which may be of two types (or not used at all).

(i) Query Status - a '1' indicates that an associated Queue is non-empty and has data available to be read.

(ii) Status Register Summary - reports the occurrence of an enabled event monitored by a Status Register Structure.

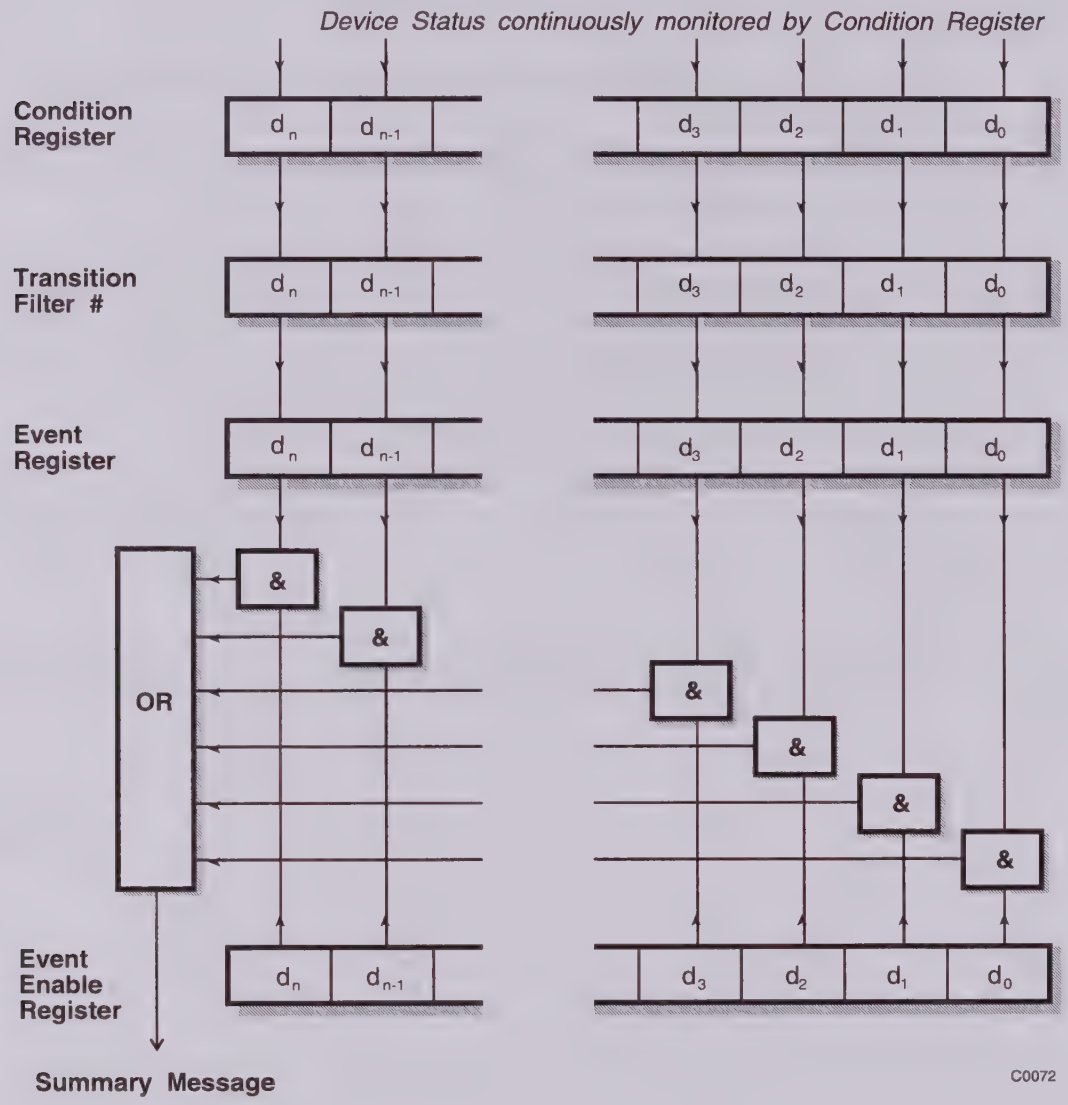
The Service Request Enable Register determines which of the bits can generate an SRQ, this register may be set by *SRE or read by *SRE?. If the bitwise -AND of the Status Byte and the Enable Register is non-zero the Flag Master Summary Status (<mss>) is True. Bit 6 of the Status byte value read by *STB? holds <mss>. However bit 6 of the Status Byte when Serial Polled is the Request For Service bit used to determine which device on the Bus has asserted SRQ, and is cleared by a Serial Poll.

The IEEE 488.2 Standard defines bit 4 as Message Available (<mav>), the Queue Summary for the Output Buffer, indicating whether any part of a Response Messages is available to be read. Bit 5 is the Event Summary Bit (<esb>), the Summary Message from the Standard Event Status Register.

In 2030 series, bit 7 is a Queue Summary for the Error Queue. Bits 1, 2, and 3 are Status summaries for the Instrument Status, Coupling Status and Hardware Status Registers. Bit 0 is unused.

STATUS DATA STRUCTURE - REGISTER MODEL

Below is a generalised model of the Register Set which funnels the monitored data into a single summary bit to set the appropriate bit in the Status Byte.



Notes...

The Device Status is continuously monitored by the Condition Register. If a Query to read a Condition Register is provided, the Response represents the Status of the instrument at the moment the Response is generated. A Condition Register cannot be written to.

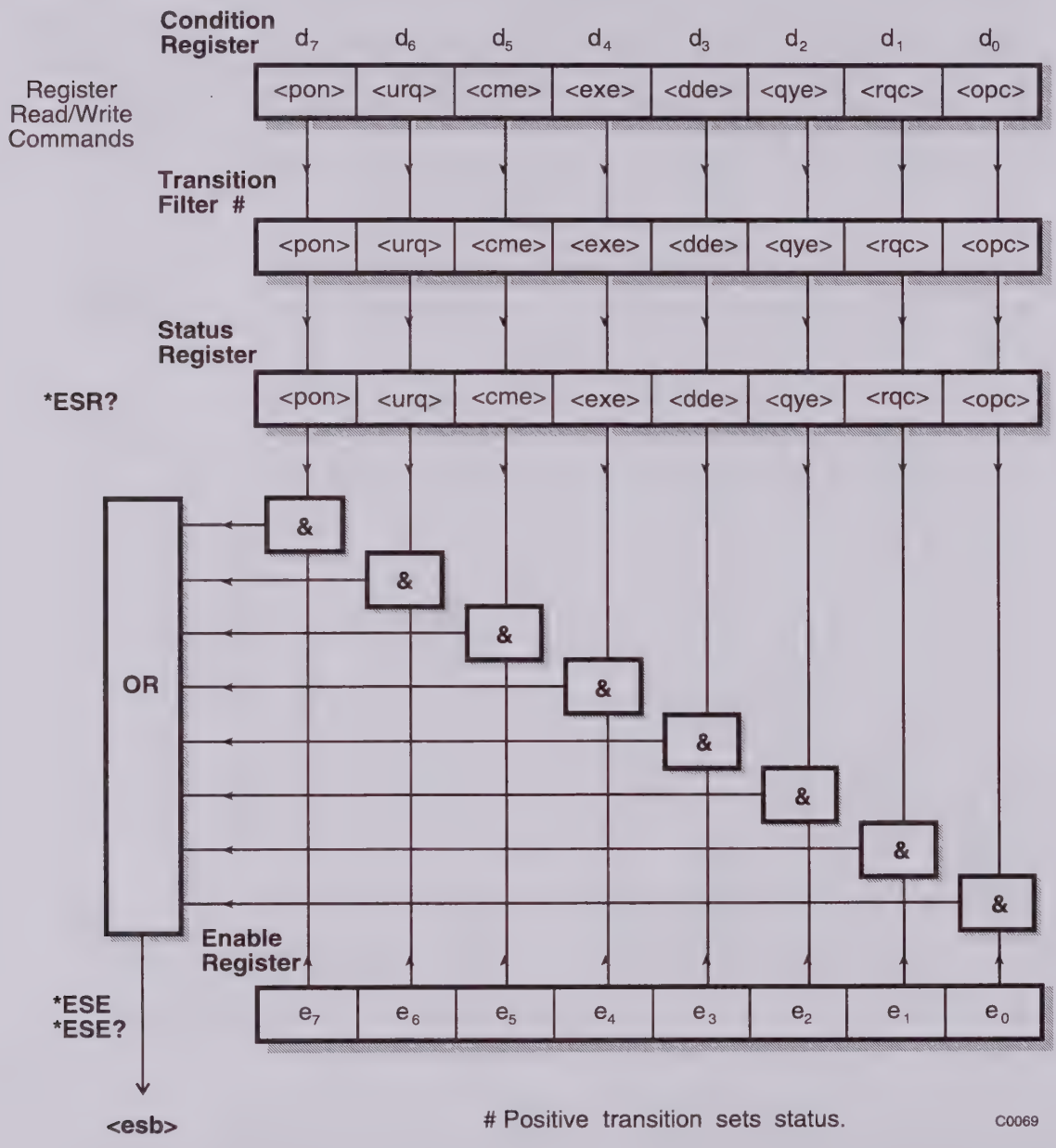
The Transition Filter determines which transition of the Condition Register data bits will set the corresponding bit in the Event Register. Either positive-going, negative-going or both transitions can set bits in an Event Register. But in the 2030 series the Transition Filters are pre-set as either Positive or Negative, as described in the following pages.

The bits in an Event Register are "latched". Once set they remain set, regardless of subsequent changes in the associated condition bit until the Event Register is cleared by being read or by the *CLS common command. Once cleared, an Event Register bit will only be set again if the appropriate change in the Condition bit occurs.

The Event Enable Register may be both written to and read from. It is bitwise AND-ed with the Event Register and if the result is non-zero the Summary Message is true, otherwise the Summary Message is false. Enable Registers are not affected by *CLS but are however clear at power-on.

STANDARD EVENT REGISTERS

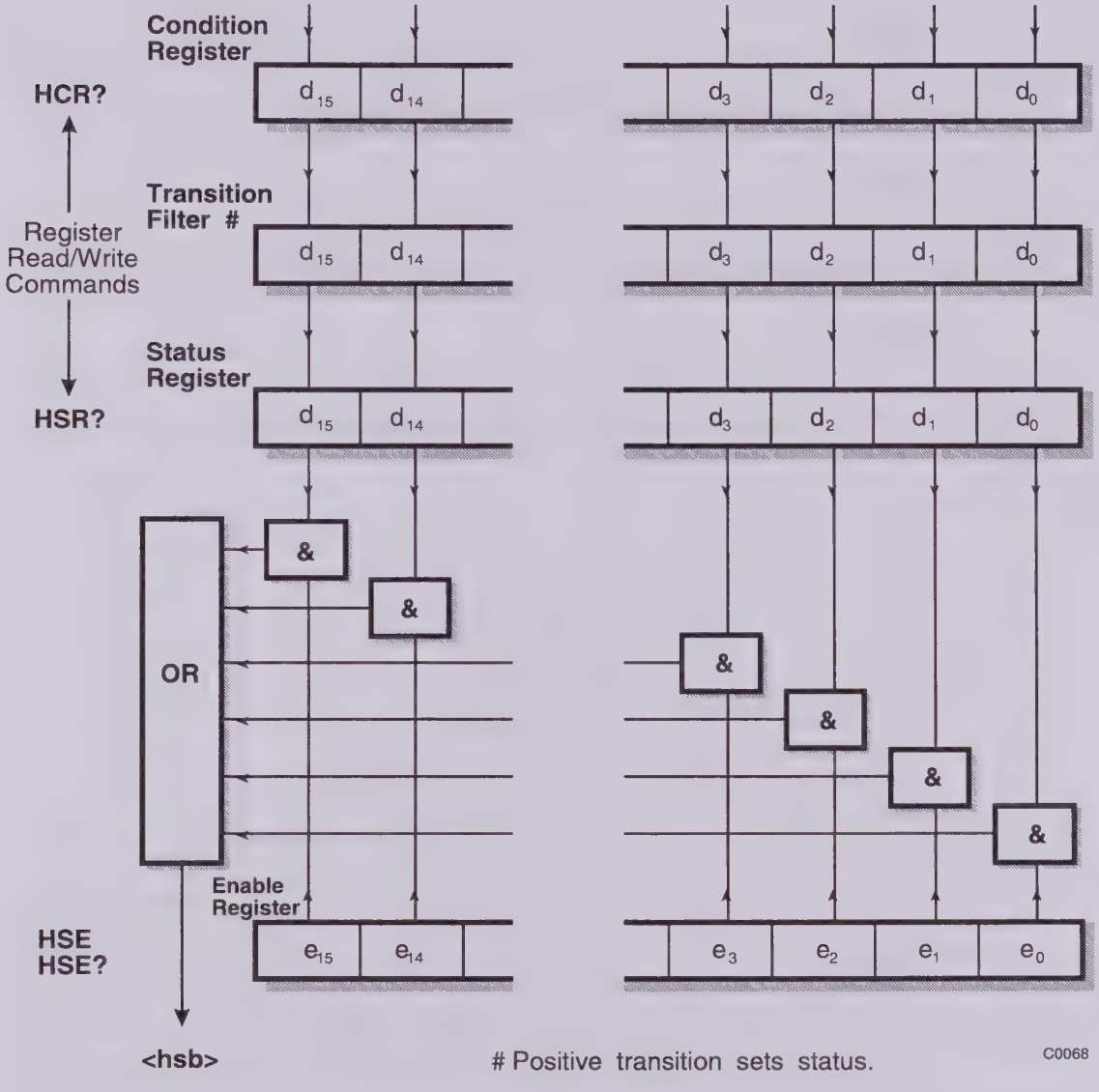
This Register is defined by IEEE 488.2 and each bit has the meaning shown below:-



<pon>	power on
<urq>	user request - used by screen edit facility
<cme>	command error
<exe>	execution error
<dde>	device dependent error
<qye>	query error
<rqc>	request control - not implemented in this product
<opc>	operation complete - set in response to the *OPC command for synchronisation.
<esb>	standard event register summary bit

HARDWARE EVENT REGISTERS

This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.

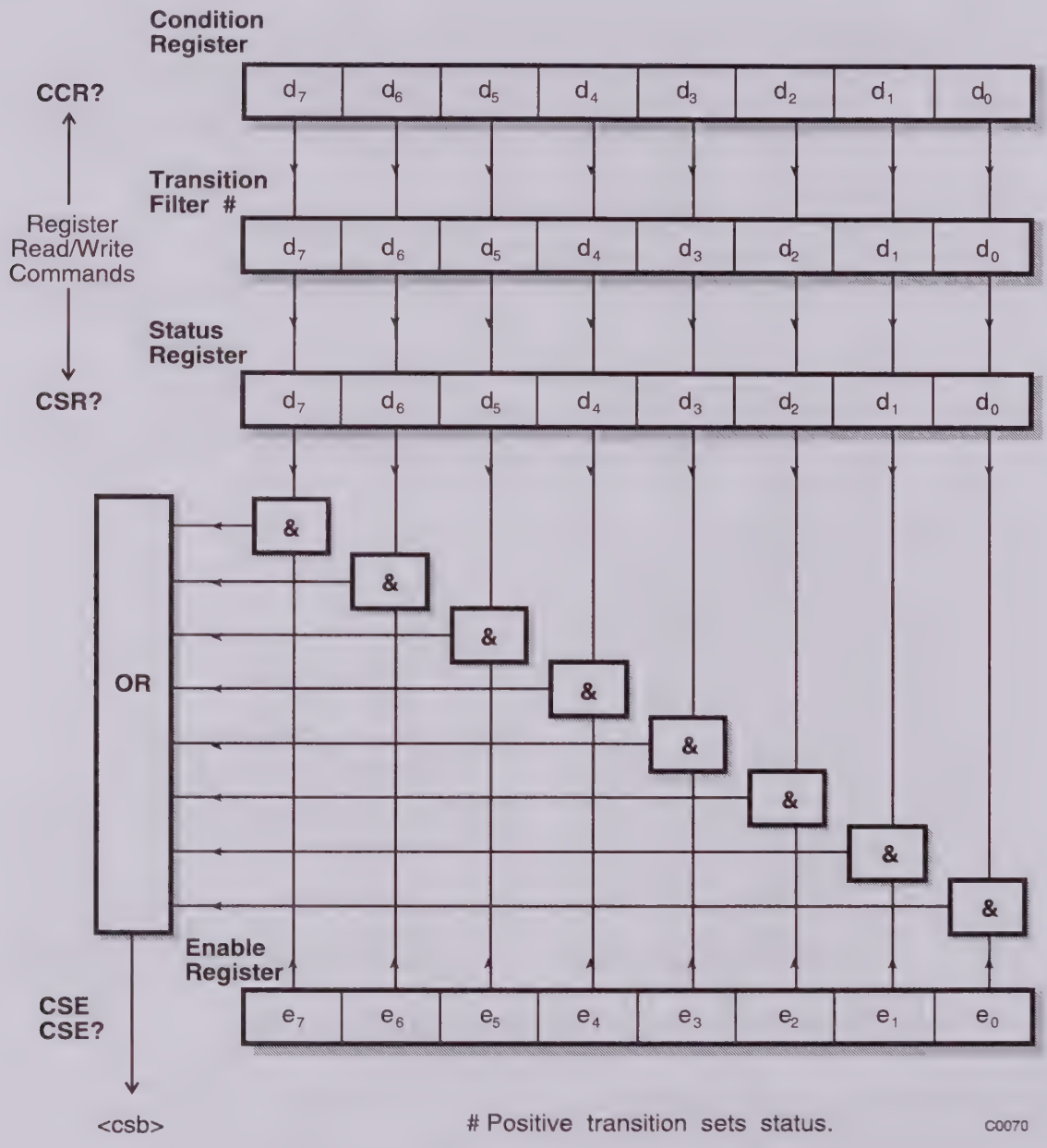


d_0	reverse power protection tripped	d_8	not used
d_1	fractional-n system out-of-lock	d_9	not used
d_2	vcxo out-of-lock	d_{10}	not used
d_3	frequency standard missing	d_{11}	not used
d_4	external mod 1 alc loop signal too low	d_{12}	not used
d_5	external mod 1 alc loop signal too high	d_{13}	not used
d_6	external mod 2 alc loop signal too low	d_{14}	rf level uncalibrated
d_7	external mod 2 alc loop signal too high	d_{15}	extended hysteresis

<hsb> hardware event register summary bit

COUPLING EVENT REGISTERS

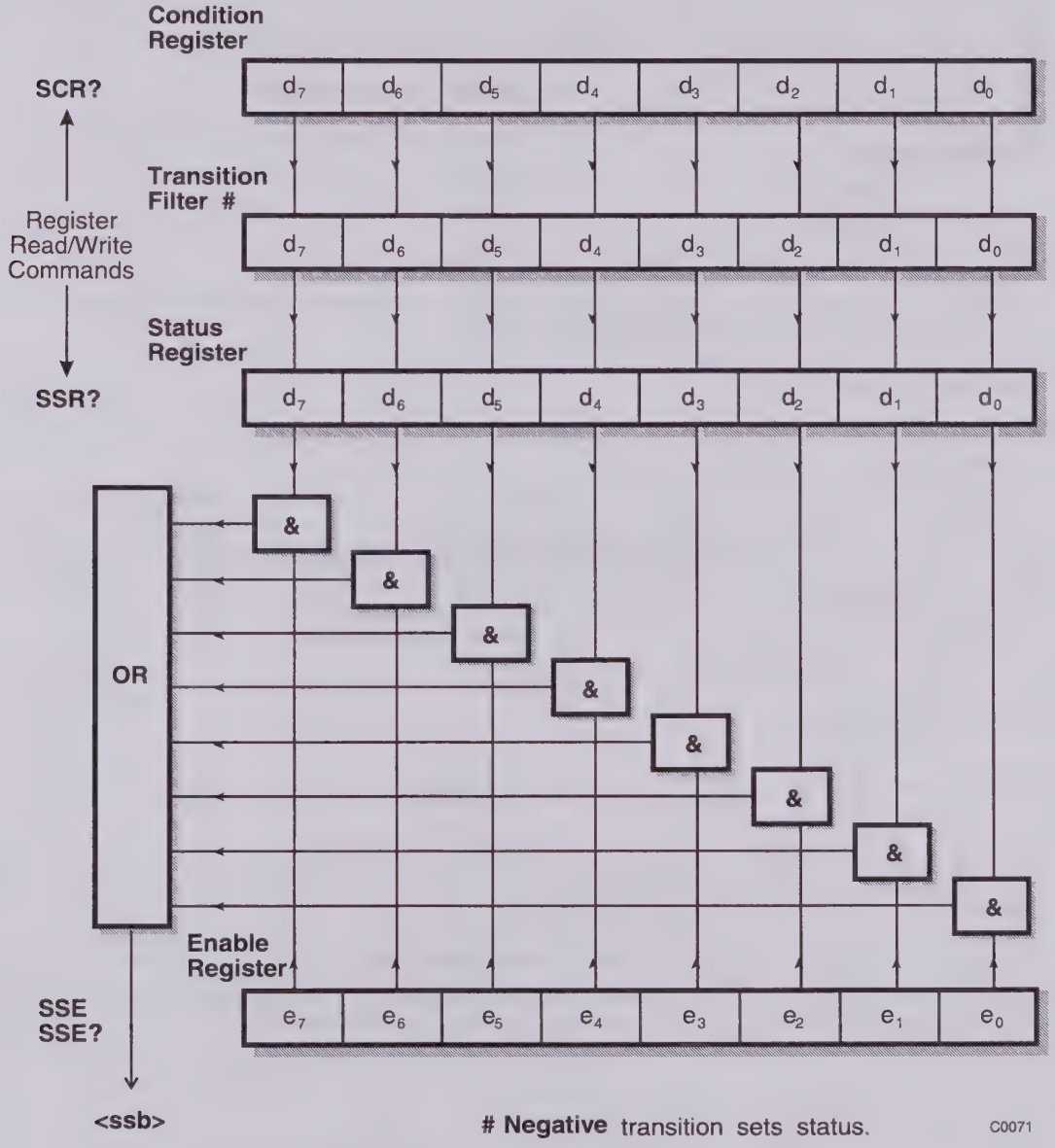
This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.



d_0	rf level restricted by requested am
d_1	fm restricted by requested carrier frequency
d_2	widebandfm restricted by requested carrier frequency
d_3	am2 depth restricted by requested am1 depth
d_4	fm2 deviation restricted by requested fm1 deviation
d_5	pm2 deviation restricted by requested pm1 deviation
d_6	number of sweep steps restricted by other parameters
d_7	not used
<csb>	coupling event register summary bit

INSTRUMENT EVENT REGISTERS

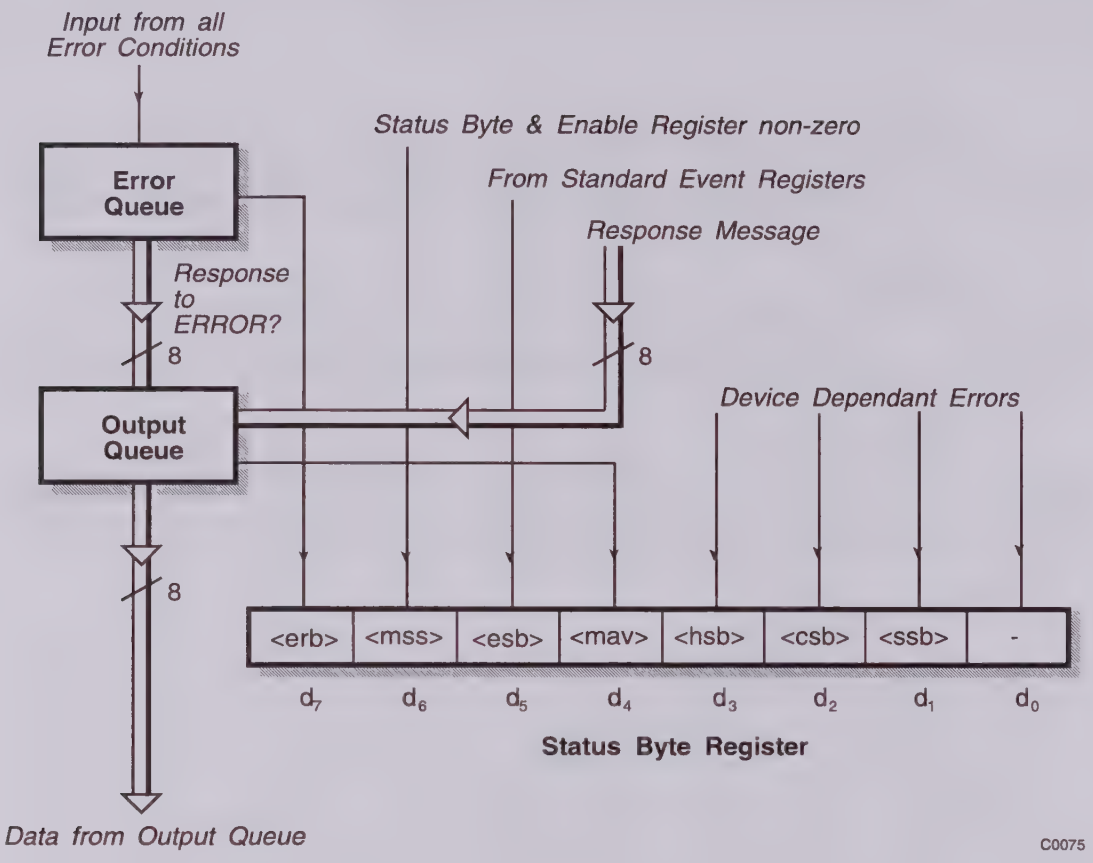
This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.



	Condition (*SCR?)	Event Status (*SSR?)
d_0	sweep in progress	end of sweep
d_1	sending tones	tones sent
d_2	selfcal in progress	selfcal completed
d_3	dc fm null in progress	dc fm null completed
d_4	not used	not used
d_5	not used	not used
d_6	not used	not used
d_7	not used	not used

<ssb> instrument event register summary bit

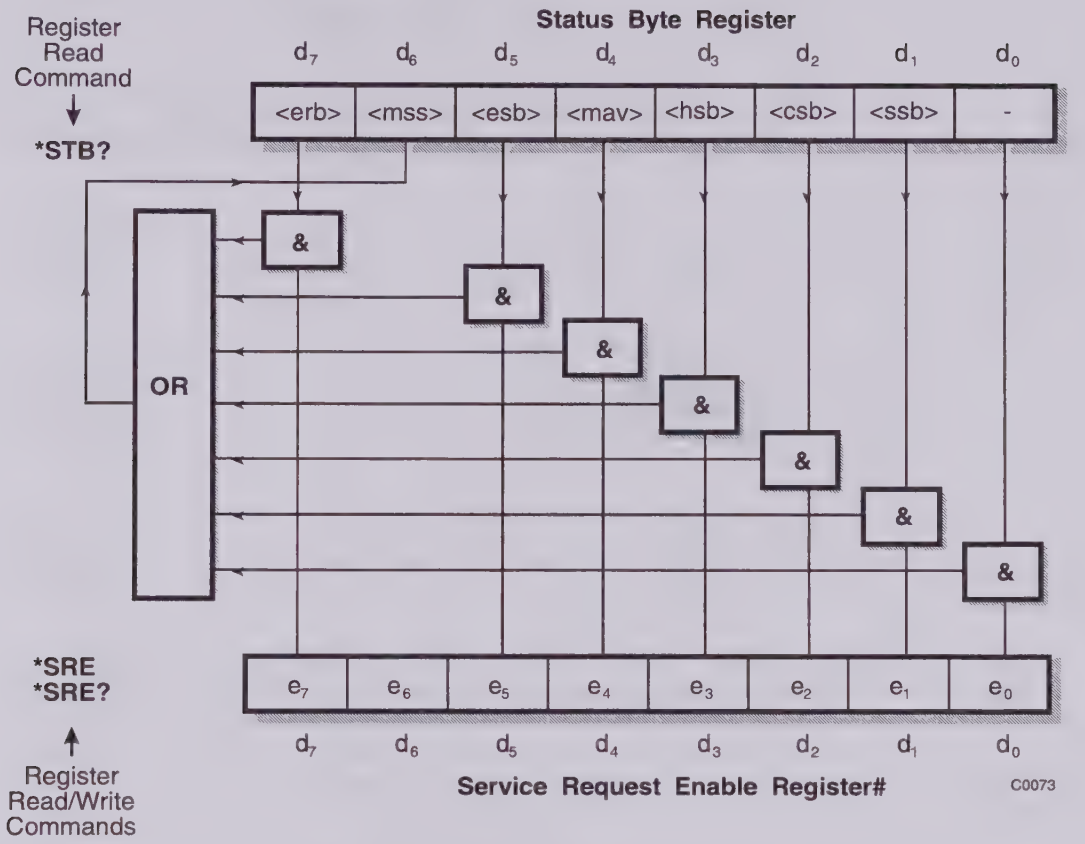
QUEUE FLAG DETAILS



The <mav> status bit is set when one or more bytes are available to be read from the Output Queue.

The <erb> status bit is set when one or more errors are present in the Error Queue. The ERROR? query will place a nr1 response message in the Output Queue representing the Error at the head of the queue, if the queue is empty then this message will be 0.

STATUS BYTE WHEN READ BY *STB?



Bit 6 in this register ignores data sent by *SRE and always returns 0 in response to *SRE?

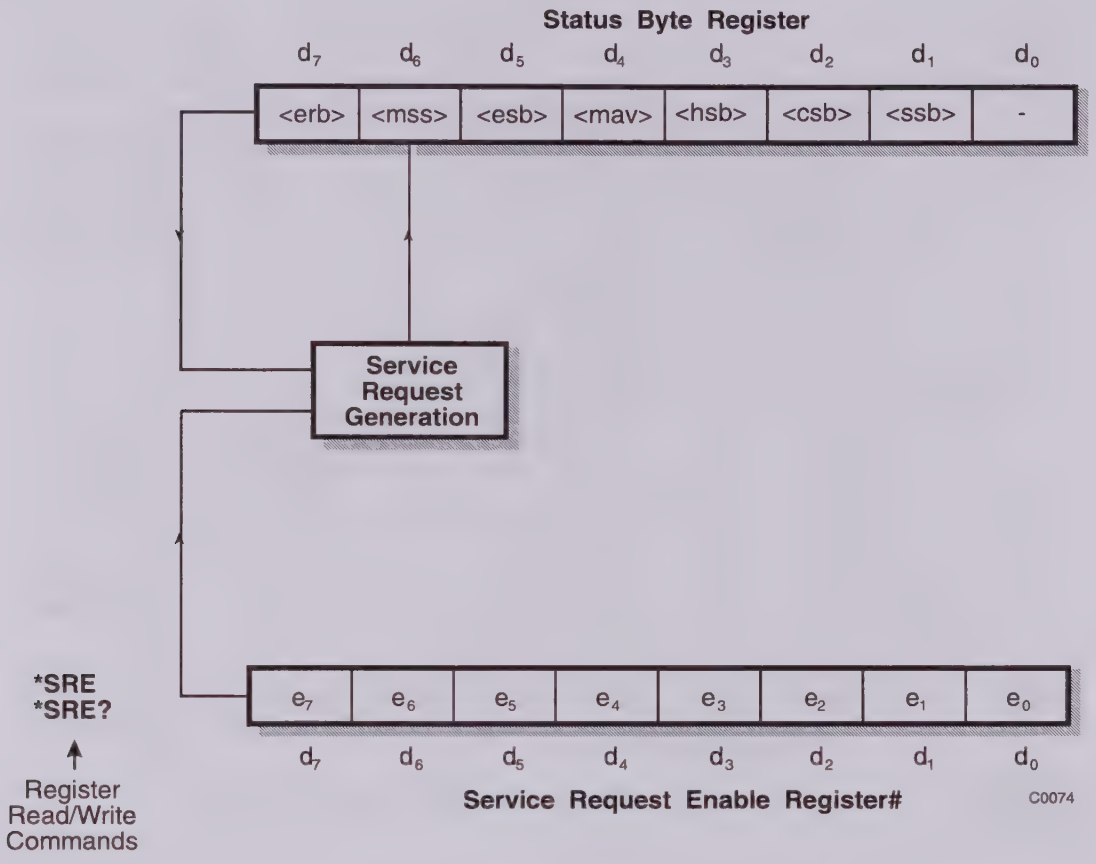
<rqs>, <esb> and <mav> are defined in IEEE 488.2

<erb> is a device defined queue summary bit indicating that the error queue is non-empty.
<mss> is true when (Status Byte) AND (Enable register) > 0.
<esb> is the standard event register summary bit.
<mav> is 'message available' indicating that the output queue is non-empty.
<hsb> is 'hardware status' summary bit
<csb> is 'coupling status' summary bit
<ssb> is 'instrument status' summary bit

Note...

The Status Byte Register is Not cleared by the *STB? query.

STATUS BYTE WHEN READ BY SERIAL POLL



Bit 6 in this register ignores data sent by *SRE and always returns 0 in response to *SRE?

<erb> is a device defined queue summary bit indicating that the error queue is non-empty.
<rqs> is set by a request for service and is cleared by the poll.
<esb> is the standard event register summary bit.
<mav> is 'message available' indicating that the output queue is non-empty.
<hsb> is 'hardware status' summary bit
<csb> is 'coupling status' summary bit
<ssb> is 'instrument status' summary bit

<rqs>, <esb> and <mav> are defined in IEEE 488.2

<rqs> (request for service) will produce an SRQ at the controller. It is set by a change to either the Status Byte or the Service Enable Register that results in a New Reason for Service. It is cleared when <mss> goes FALSE (i.e. no reason for service) or by Serial Poll.

SUMMARY OF STATUS REPORTING COMMANDS AND QUERIES

***CLS**	Clears Status Registers and the Error Queue
***ESE<nrf>**	Writes to Standard Event Enable Register
***ESE?**	Reads from Standard Event Enable Register
***ESR?**	Reads from Standard Event Status Register
***SRE<nrf>**	Writes to Service Request Enable Register
***SRE?**	Reads from Service Request Enable Register
***STB?**	Reads from Status Byte Register
CCR?	Reads from Coupling Condition Register
CSE<nrf>	Writes to Coupling Status Enable Register
CSE?	Reads from Coupling Status Enable Register
CSR?	Reads from Coupling Status Register
HCR?	Reads from Hardware Condition Register
HSE<nrf>	Writes to Hardware Status Enable Register
HSE?	Reads from Hardware Status Enable Register
HSR?	Reads from Hardware Status Register
SCR?	Reads from Instrument Condition Register
SSE<nrf>	Writes to Instrument State Enable Register
SSE?	Reads from Instrument State Enable Register
SSR?	Reads from Instrument State Status Register
<nrf>	Decimal Numeric Program Data

All of the above queries respond with a nr1 numeric format.

Chapter 4-1
BRIEF TECHNICAL DESCRIPTION

INTRODUCTION

The 2030 series signal generators cover a wide range of frequencies from 10 kHz to 1.35 GHz (2030), 10 kHz to 2.7 GHz (2031) and 10 kHz to 5.4 GHz (2032). Output levels from -144 or -138 dBm to +13 dBm (+19 dBm on 2030 with Option 003 fitted) are available. The simplified block schematic diagram for the instrument is shown in Fig. 4-1.

MODULATION

The carrier frequency can be frequency, phase or amplitude modulated from internal or external modulation sources. A maximum of four modulation channels can be made available by the use of the internal oscillator and a second optional internal oscillator together with two external modulation signals applied to the EXT MOD 1 INPUT and EXT MOD 2 INPUT connectors on the front panel.

FREQUENCY GENERATION

Four voltage controlled oscillators (VCOs) covering the frequency range 675 to 1350 MHz are phase locked to a 10 MHz oven controlled crystal oscillator using a fractional-N synthesizer system. Additional frequency coverage is achieved by means of frequency division or multiplication. Low frequencies are generated by a beat frequency oscillator (BFO) system.

DISPLAY

The display is a high definition dot matrix liquid crystal panel with backlighting to cater for variations in ambient light conditions. The display can be adjusted for both contrast and brightness.

CONTROL

The 2030 series are menu driven instruments. Main menus are displayed by the use of hard keys, and parameters are changed by means of soft keys which change as the menu changes. Internal control of the instruments is achieved by a microprocessor which receives data from the various controls and sends instructions via an internal 8-bit data bus to the signal processing circuits.

The instruments can also be controlled by the built in general purpose interface bus (GPIB). This facility enables the instruments to be used both as manually operated bench mounted instruments or as part of a fully automated test system.

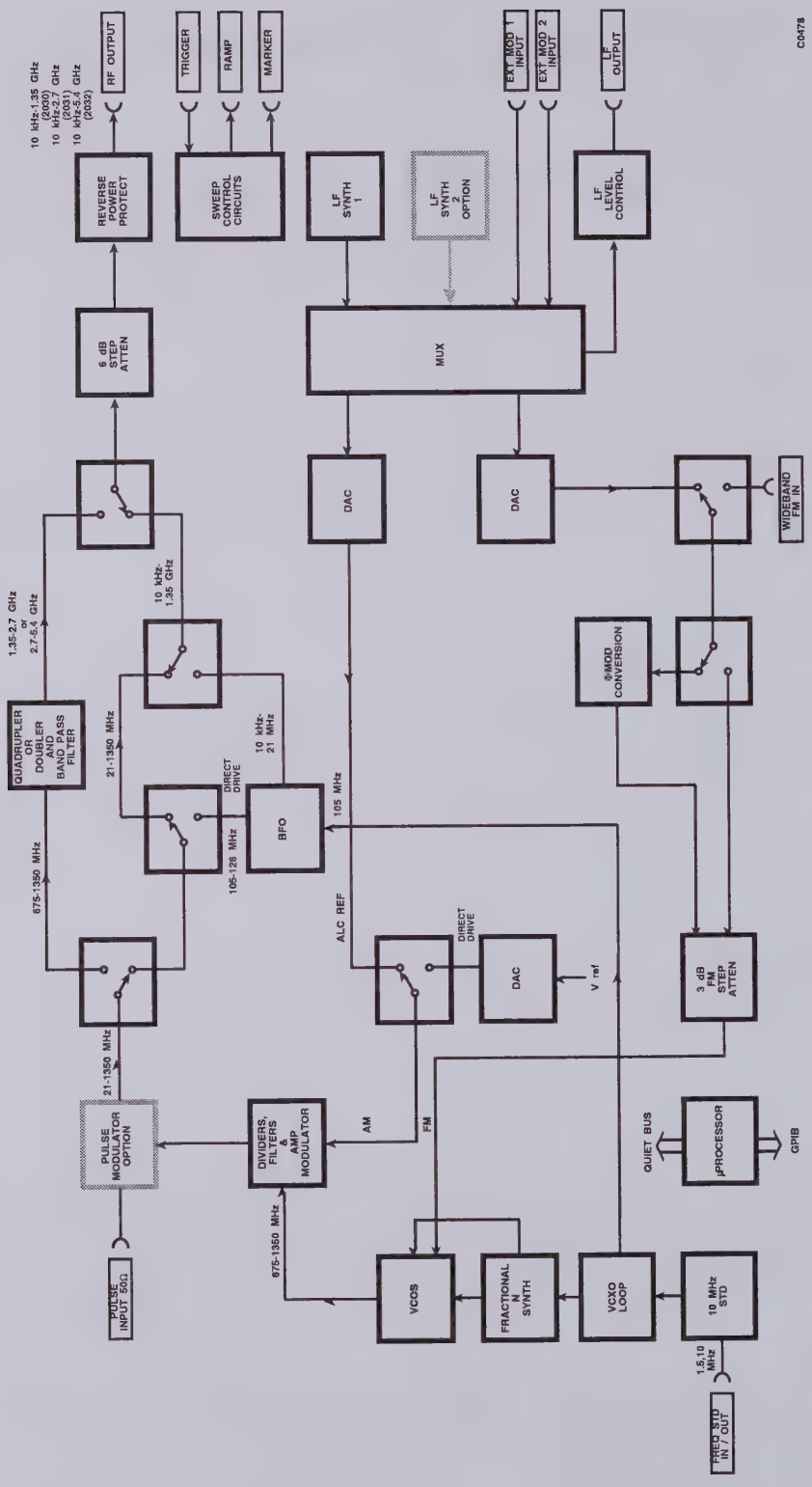


Fig. 4-1-1 Block schematic diagram

Chapter 5-1
ACCEPTANCE TESTING

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Fig. 5-1-14 SSB phase noise test set-up 5-1-28

INTRODUCTION

Test procedures described in this chapter may be simplified and of restricted range compared with those that relate to the generally more comprehensive factory test facilities which are necessary to demonstrate complete compliance with the specifications.

Performance limits quoted are for guidance and should not be taken as guaranteed performance specifications unless they are also quoted under 'Performance Data' in Chapter 1.

When making tests to verify that the instrument meets the stated performance limits, always allow for the uncertainty of the test equipment.

For those signal generators with options fitted, the appendixes at the end of this Chapter and the Annexes at the end of this manual must be referred to.

RECOMMENDED TEST EQUIPMENT

The test equipment recommended for acceptance testing is shown in Table 5-1-1. Alternative equipment may be used provided it complies with the stated minimum specification.

TABLE 5-1-1 RECOMMENDED TEST EQUIPMENT

Description	Minimum specification	Example
Power meter	±0.1 dB from 10 kHz to 5.4 GHz	Marconi 6960A and 6910 or 6912 sensor
Measuring receiver	0 dBm to -127 dBm; 2.5 to 1300 MHz	HP8902A and 11722A sensor and 11793A down converter#
Signal generator	8 dBm from 32.5 MHz to 5.4 GHz	Marconi 2032
Frequency counter	10 Hz to 5.4 GHz	Marconi 2440
Audio analyzer	Capable of measuring THD below 0.03%m from 50 Hz to 20 kHz. Capable of measuring 0.5 mV ±3% and levels at 10 Hz	HP8903B or Rhode & Schwarz UPA3
Digital multimeter	DC to 500 kHz, 1 mV to 5 V	Datron 1061A
Modulation meter	AM, FM and ΦM. 1.5 MHz to 1 GHz. Accuracy better than 1.1%. Modulation freqs from 30 Hz to 50 kHz. Capable of measuring Residual FM less than 7 Hz.	Marconi 2305 plus distortion option*
Spectrum analyzer	10 kHz to 16.2 GHz Capable of measuring less than -70 dBm.	Marconi 2386
Function generator	DC to 500 kHz sine ±0.6 dB flatness	HP3325B

* The distortion option of the 2305 Modulation Meter allows modulation distortion tests to be carried out with greater ease. If a 2305 with a distortion option is not available, the Audio Analyzer may be connected to the Modulation Meter LF output and set to measure distortion.

If receiver and down converter are not available, an alternative procedure to ensure attenuator pad accuracy using a power meter is given.

TEST PROCEDURES

Before each test, it is recommended that the UUT is reset to its switch-on conditions which are as follows:

Carrier freq	1.35 GHz (2030), 2.7 GHz (2031), 5.4 GHz (2032)
RF level	-144 dBm
FM	0 Hz ON
Single modulation mode	
Modulation	ENABLED

RF OUTPUT

SPECIFICATION	
Level range:	-127 dBm to +13 dBm (usable to -144 dBm)
Accuracy:	**(2030, 2031 and 2032)** ±0.85 dB from 10 kHz to 1.35 GHz at levels >-127 dBm ±0.50 dB from 10 kHz to 1.35 GHz at levels >0 dBm **(2031 and 2032)** ±1.0 dB from 1.35 GHz to 2.7 GHz at levels >-127 dBm ±0.7 dB from 1.35 GHz to 2.7 GHz at levels >0 dBm **(2032 only)** ±1.5 dB from 2.7 GHz to 5.4 GHz at levels >-100 dBm ±1.5 dB from 2.7 GHz to 5.4 GHz at levels >-50 dBm ±1.0 dB from 2.7 GHz to 5.4 GHz at levels >0 dBm

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
RF power meter	±0.1 dB from 30 kHz to 2.7 GHz	Marconi 6960A and 6910 or 6912 sensor
Measuring receiver	0 dBm to –127 dBm; 2.5 MHz to 1300 MHz	HP 8902A and 11722A sensor and 11793A down converter
Signal generator	8 dBm from 32.5 MHz to 5.4 GHz	Marconi 2032

TEST PROCEDURES

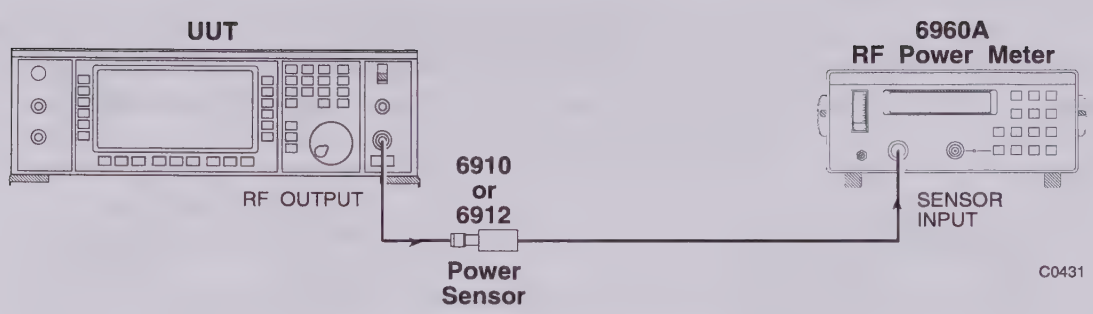

Fig. 5-1-1 RF output test set-up

(1) Connect the test equipment as shown in Fig. 5-1-1.
(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 30 kHz.
(3) Check that the output level is within specification at the frequencies shown in Table 5-1-2.

When checking a 2032 signal generator, the 6912 sensor must be replaced with 6910 sensor for frequencies above 2700 MHz.z.

(4) Set the UUT RF output to 7 dBm and repeat (3) above.
(5) Set the UUT RF output to 13 dBm and repeat (3) above.

TABLE 5-1-2 FREQUENCY SETTINGS FOR OUTPUT LEVELS

FREQUENCY (MHz)				
(2030/1/2)	1125	2025	2925	4425
0.03	1275	2175	3075	4575
0.1	1350	2325	3225	4725
75		2475	3375	4875
225	**(2031/2)**	2625	3525	5025
375	1351	2700	3675	5175
525	1425		3825	5325
675	1575	**(2032)**	3975	5400
825	1725	2701	4125	
975	1875	2775	4275	

ALC linearity

(1) Connect the test equipment as shown in Fig. 5-1-1.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 2.5 MHz.

(3) Increment the RF output of the UUT in 1 dB steps up to 12 dBm and in 0.1 dBm steps up to 13 dBm, measuring the RF level at each step. Check that the RF output level variation is within ±0.1 dB.

(4) Set the UUT carrier frequency to 500 MHz and repeat (3) above.

(5) Set the UUT carrier frequency to 2.7 GHz and repeat (3) above.

(6) Replace the 6912 sensor with the 6910 sensor, set the UUT carrier frequency to 5.4 GHz and repeat (3) above.

Attenuator accuracy

The following test will confirm that the attenuator performs to the published performance specification. In the event of the receiver/down converter not being available, an alternative method to functionally test the attenuator is also suggested (see 'Alternative attenuator functional check' below).

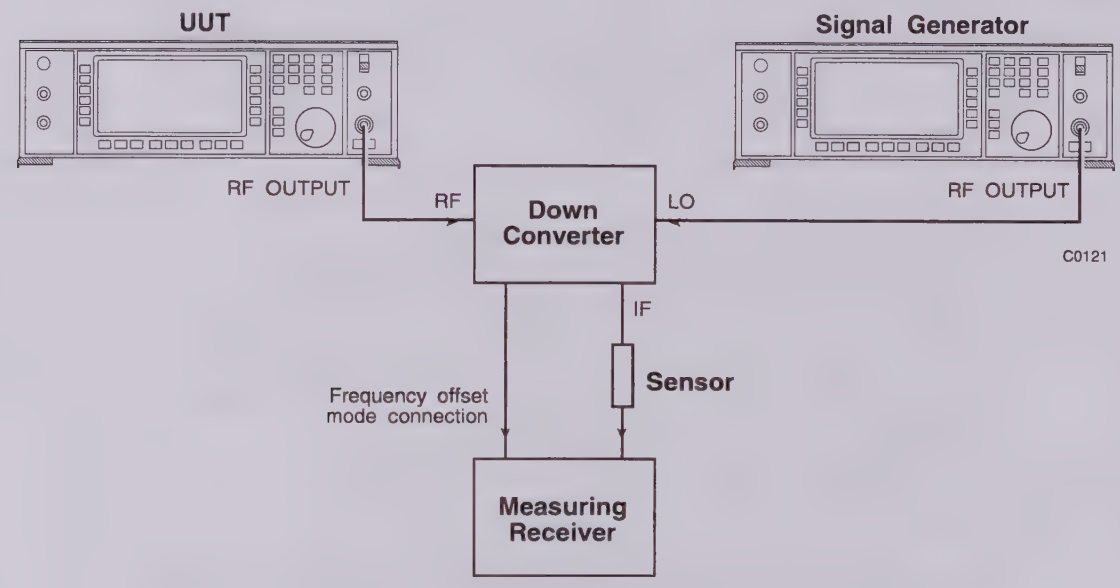

Fig. 5-1-2 Attenuator accuracy test set-up

(1) Connect the test equipment as shown in Fig. 5-1-2.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 2.5 MHz.

(3) Tune the receiver to 2.5 MHz and measure the RF level.

(4) Set the UUT to *[RF Level]* -6.1 dBm and measure the RF level.

(5) Decrement the output of the UUT in 6 dB steps down to an RF level of -120.1 dBm measuring the RF level at each step. Check that the measured level is within specification.

(6) Repeat (2) to (5) at the frequencies given in Table 5-1-3.

(7) Set the local oscillator to +8 dBm at the frequencies indicated in brackets in Table 5-1-3.

TABLE 5-1-3 ATTENUATOR FREQUENCY SETTINGS

Frequency (MHz)		
2030/1/2	***2031/2**	****2032**
2.5	1725 (1662)	2775 (2712)
31	2700 (2637)	4125 (4062)
325		5400 (5337)
1125		
1275		

*At frequencies above 1300 MHz the down converter will automatically be enabled.

**At frequencies above 2700 MHz it is only necessary to test down to -96.1 dBm (determined by 8902 accuracy).

The frequency of the local oscillator will have to be entered on the receiver followed by the test frequency. This will automatically set the receiver to the required IF frequency.

Alternative attenuator functional check

(1) Connect the test equipment as shown in Fig. 5-1-1.

(2) Set the UUT to *[Carrier Freq.]* 1.35 GHz *[RF Level]* 13 dBm.

(3) Set a reference on the power meter.

(4) Using the latch poke facility on the UUT, select each attenuator pad individually as follows:

[UTIL] *[Utils. Menu 2] [Latch Data]* 95 [enter]
[Decimal/Binary]

The binary latch data will now appear in the bottom right-hand side of the display.

(5) By using the *[Toggle Bit]* and the *[Cursor Left] [Cursor Right]* soft keys, select each attenuator pad in turn which should give the nominal readings on the power meter in the following sequence:

-24 dB -36 dB -6 dB -12 dB -24 dB -36 dB

Note that no software correction is applied to the attenuator when performing this test.

CARRIER FREQUENCY ACCURACY

SPECIFICATION	
Frequency range:	10 kHz to 1.35 GHz (2030) 10 kHz to 2.7 GHz (2031) 10 kHz to 5.4 GHz (2032)
Accuracy:	Determined by the frequency standard accuracy
Resolution:	0.1 Hz

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Frequency counter	10 kHz to 5.4 GHz	Marconi 2440

TEST PROCEDURES

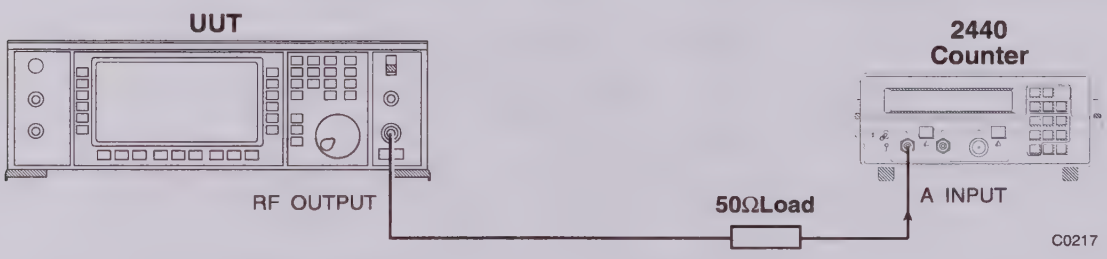

Fig. 5-1-3 Carrier frequency accuracy test set-up

(1) Connect the test equipment as shown in Fig. 5-1-3.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 10 kHz.

(3) Referring to Table 5-1-4, check that the carrier frequencies can be selected correctly and are within specification. It will be necessary to disconnect the 50 ohm load and reconnect the UUT RF OUTPUT to the B input and C input where indicated.

TABLE 5-1-4 CARRIER FREQUENCIES

Carrier Frequencies (Hz)

(2030/1/2) A Input	B Input		(2032)
		805,306,368.0	2,700,001,000.0
		952,945,868.8	5,400,000,000.0
10,000.0	168,749,999.9	959,656,755.2	
4,226,750.0	337,499,999.9	1,134,139,801.6	
8,443,500.0	572,662,306.1	1,140,850,688.0	
12,660,250.0		1,145,324,612.2	
16,887,000.0	**C Input**	1,348,888,166.4	
21,093,749.9			
21,039,750.0	674,999,999.9	**(2031/2)**	
42,187,499.9	677,799,526.4	1,350,001,000.0	
84,374,999.9	798,595,481.6	2,700,000,000.0	

MODULATION OSCILLATOR

SPECIFICATION	
Frequency range:	0.1 Hz to 500 kHz
Accuracy:	Equal to the frequency standard accuracy
Resolution:	0.1 Hz
Distortion:	Less than 0.1% THD at frequencies up to 20 kHz sine wave mode

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Frequency counter	10 Hz to 500 kHz	Marconi 2440
Audio analyzer	Capable of measuring down to 0.03% THD from 100 Hz to 20 kHz	HP 8903B Rhode & Schwarz UPA 3

TEST PROCEDURES

Modulation oscillator frequencies

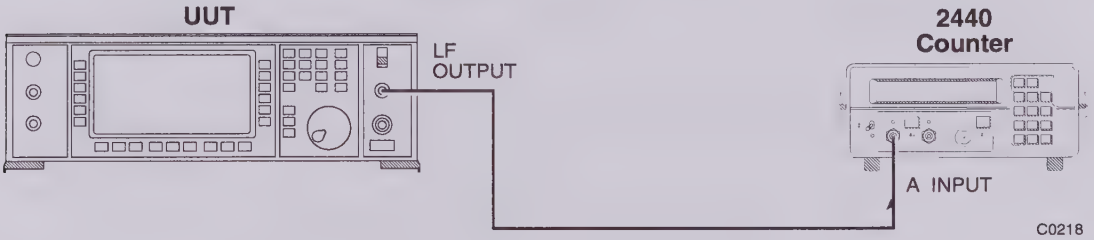

Fig. 5-1-4 Modulation oscillator frequencies test set-up

(1) Connect the test equipment as shown in Fig. 5-1-4.

(2) Set the UUT to *[Source Freq: F4]* 10 Hz.

(3) Referring to Table 5-1-5, check that the oscillator frequencies can be selected correctly and are within specification.

TABLE 5-1-5 MODULATION OSCILLATOR FREQUENCIES

Modulation oscillator frequencies (Hz)	
10.00	279,620.20
139,810.10	500,000.00

Modulation oscillator distortion

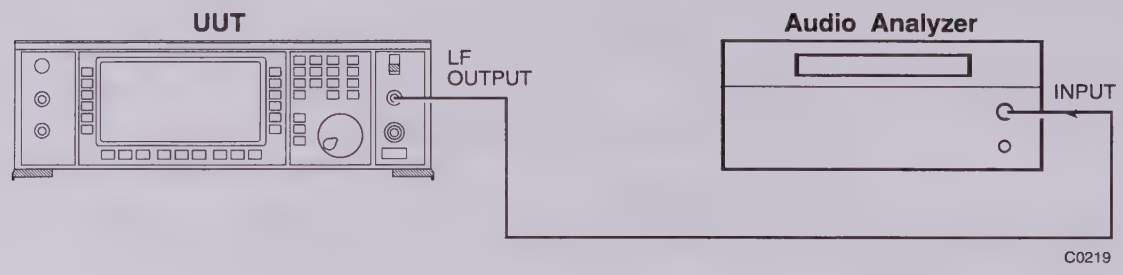

Fig. 5-1-5 Modulation oscillator distortion test set-up

(1) Connect the test equipment as shown in Fig. 5-1-5.

(2) Set the UUT to *[Source Freq: F4]* 100 Hz.

(3) Check that the distortion measured on the audio analyzer at the frequencies indicated in Table 5-1-6 is less than 0.1%.

TABLE 5-1-6 DISTORTION FREQUENCY SETTINGS

Modulation oscillator frequencies	
100 Hz	10 kHz
1 kHz	20 kHz

LF OUTPUT

SPECIFICATION	
Level accuracy:	±5% for levels above 50 mV ±10% for levels from 500 µV to 50 mV (With a load impedance >10 kΩ)
Frequency response:	Typically better than 1 dB from 0.1 Hz to 300 kHz

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Digital multimeter	DC to 300 kHz, 1 mV to 5 V	Datron 1061A
Audio analyzer	Capable of measuring 0.5 mV ±3% and levels at 10 Hz	HP 8903B Rhode & Schwarz UPA3

TEST PROCEDURES

Level accuracy

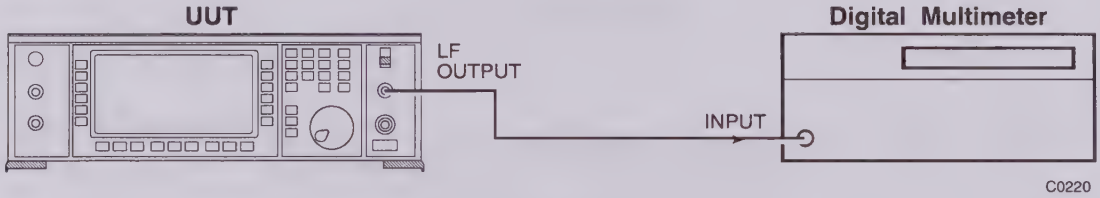

Fig. 5-1-6 Level accuracy test set-up

(1) Connect the test equipment as shown in Fig. 5-1-6.

(2) Set the UUT to give an LF output of 5 V at 1 kHz as follows:

[LF] *[LF Gen] [LF Freq]* 1 kHz *[LF Level]* 5 V

(3) The level measured on the digital multimeter should read 5 V ±0.25 V.

(4) Check the LF output of the UUT at the levels indicated in Table 5-1-7. Check that the measured levels are within specification.

TABLE 5-1-7 LEVEL ACCURACY OUTPUT LEVELS

LF output levels (V)		
5.0000	0.1000	0.0050
2.0000	0.0500	0.0020
1.0000	0.0200	0.0010
0.5000	0.0100	*0.0005
0.2000		

*For the last measurement it will be necessary to use the audio analyzer. Connect the test equipment as shown in Fig. 5-1-5.

Frequency response

(1) Connect the test equipment as shown in Fig. 5-1-6.

(2) Set the UUT to give an LF output of 1 V at 1 kHz on the first modulation oscillator (see 'Level accuracy' (2) above).

(3) Reference this level on the digital voltmeter using the dB relative function.

(4) Set the modulation oscillator to the frequencies given in Table 5-1-8 measuring the difference from the reference in (3) above which should be less than 1 dB.

TABLE 5-1-8 FREQUENCY RESPONSE TEST FREQUENCIES

Test frequencies		
*10 Hz	1 kHz ref	70 kHz
*30 Hz	10 kHz	100 kHz
*100 Hz	30 kHz	300 kHz

* For these measurements it will be necessary to use the audio analyzer. Connect the test equipment as shown in Fig. 5-1-5, referencing the audio analyzer at 1 kHz.

EXTERNAL MODULATION

SPECIFICATION	
	With ALC off, the modulation is calibrated for an input level of 1.0 V PD RMS
	With ALC on, the modulation is calibrated for input levels between 0.7 V and 1.4 V PD RMS
Distortion:	Less than 0.1% from 50 Hz to 20 kHz at 1 V RMS
Flatness:	Typical 1 dB bandwidth, 10 Hz to 500 kHz

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Function generator	10 Hz to 500 kHz sine wave ±0.6 dB flatness	HP 3325B
Digital multimeter	10 Hz to 500 kHz	Datron 1061A
Audio analyzer	Capable of measuring THD down to 0.03% from 50 Hz to 20 kHz	HP 8903B Rhode & Schwarz UPA3

TEST PROCEDURES

Mod ALC on flatness

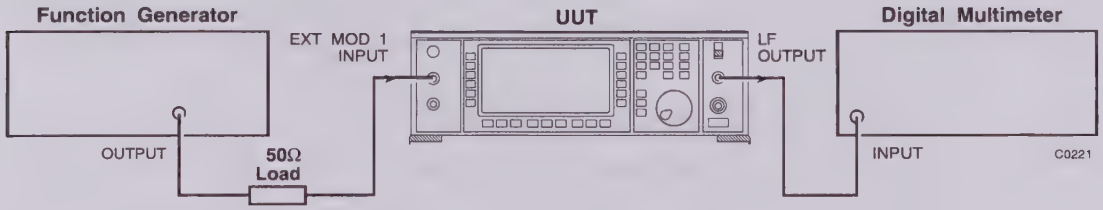

Fig. 5-1-7 External modulation test set-up

Mod input 1

(1) Connect the test equipment as shown in Fig. 5-1-7.

(2) Set the function generator to 1 V RMS sine wave output at a frequency of 1 kHz.

(3) Set the UUT to EXT MOD 1 INPUT with ALC ON as follows:

[LF] *[Mod Drive]*
[SIG GEN] *[FM]* 90 kHz *[Select Source]*
[Select External] *[Ext1 ALC Coupling]* [SIG GEN]

(4) Set the digital multimeter to read dB and measure and record this value.

(5) Set the function generator to the frequencies given in Table 5-1-9 and measure the LF output relative to that reading taken in (4) above. The difference should be less than 1 dB.

(6) Set the function generator to give 0.7 V output and repeat (4) and (5) above.

(7) Set the function generator to give 1.4 V output and repeat (4) and (5) above.

Mod input 2

(8) Connect the test equipment as in Fig. 5-1-7 except with the function generator output connected to EXT MOD 2 INPUT on the UUT.

(9) Set the UUT to EXT MOD 2 INPUT with ALC ON as follows:

[Select Source] [Ext2 ALC Coupling] [SIG GEN]

(10) Reset the function generator as in (2) above and repeat (4) to (7) above.

TABLE 5-1-9 EXTERNAL MODULATION FREQUENCIES

External modulation frequencies			
10 Hz	50 Hz	20 kHz	200 kHz
20 Hz	1 kHz ref	100 kHz	500 kHz

Modulation ALC distortion

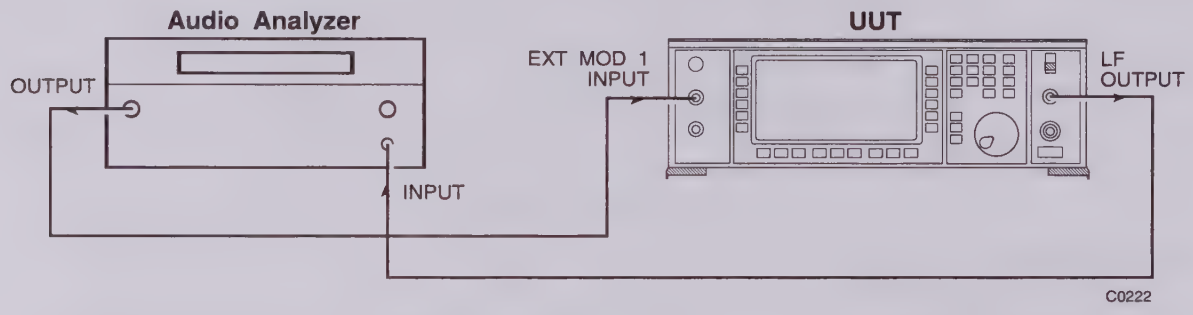

Fig. 5-1-8 Modulation ALC distortion test set-up

(1) Connect the test equipment as shown in Fig. 5-1-8.

(2) Set the UUT as in 'Mod input 1' (3) above.

(3) Set the audio analyzer to give 1 V RMS output and monitor distortion.

(4) Set the audio analyzer to 50 Hz, 1 kHz and 20 kHz measuring the distortion at each frequency which must be less than 0.1%.

(5) Connect the test equipment as in Fig. 5-1-8 except with the output from the audio analyzer connected to EXT MOD 2 INPUT on the UUT and set the UUT as in 'Mod input 2' (9) above.

(6) Repeat (4) above.

INTERNAL AM DEPTH AND DISTORTION

SPECIFICATION	
Range:	0 to 99% in 0.1% steps.
Accuracy:	For carrier frequencies up to 1 GHz, ±4% of setting ±1% depth. Usable to 1.35 GHz (2030), 2.7 GHz (2031), 5.4 GHz (2032).
Envelope distortion:	Less than 3% THD for AM depths up to 80% at 1 kHz modulation frequency. Less than 1% THD for AM depths up to 30% at 1 kHz modulation frequency.
Phase mod on AM:	Typically less than 0.1 rad at 30% depth on a 500 MHz carrier.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	1.5 MHz to 1 GHz. Accuracy: Better than 1.1%.	Marconi 2305 + distortion option

TEST PROCEDURES

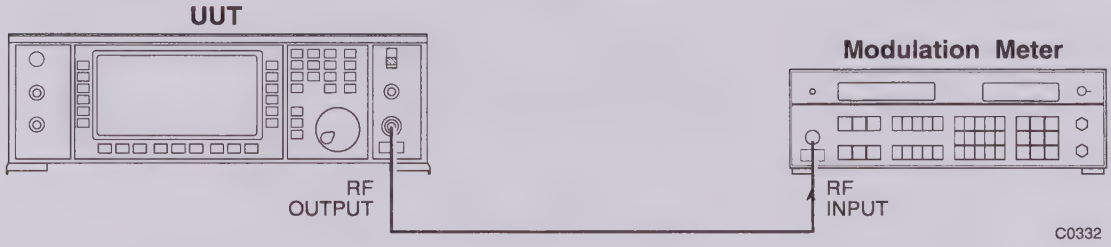

Fig. 5-1-9 Internal AM depth and distortion test set-up

(1) Connect the test equipment as shown in Fig. 5-1-9.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 1.5 MHz *[AM]* 30%.

(3) Measure the AM depth and the envelope distortion on the modulation meter using the 50 Hz to 15 kHz filter setting at the frequencies shown in Table 5-1-10. Check that the measured AM depth and distortion are within specification.

(4) Set the UUT to an AM depth of 80% and repeat (3) above.

(5) Set the UUT to *[RF Level]* 7 dBm and repeat (3) and (4) above.

TABLE 5-1-10 AM DEPTH AND DISTORTION FREQUENCIES

Carrier frequencies (MHz)	
1.5	400
31.0	500
43.0	850
200.0	1000

AM scale shape

(1) Connect the test equipment as shown in Fig. 5-1-9.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 100 MHz *[AM]* 1%.

(3) Measure the AM on the modulation meter at the depths shown in Table 5-1-11. Check that the measured depths are within specification.

TABLE 5-1-11 AM DEPTHS

AM depth (%)									
1	10	31	34	37	39.1	39.4	39.7	40	70
2	20	32	35	38	39.2	39.5	39.8	50	80
5	30	33	36	39	39.3	39.6	39.9	60	85

Phase modulation on AM

(1) With the test equipment set up as in Fig. 5-1-9, set the UUT to *[Carrier Freq.]* 500 MHz *[RF Level]* 0 dBm *[AM]* 30%.

(2) Measure the incidental phase modulation which should be typically less than 0.1 radian.

EXTERNAL AM

SPECIFICATION	
Accuracy:	With ALC OFF the modulation is calibrated for an input level of 1.0 V PD RMS sine wave.
Bandwidth:	±1 dB, DC to 30 kHz relative to 1 kHz Typically ±1 dB DC to 50 kHz, relative to 1 kHz.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	Modulation frequencies from 30 Hz to 50 kHz.	Marconi 2305
Function generator	DC to 50 kHz.	HP3325B
Power meter	Capable of measuring levels at 400 MHz.	Marconi 6960A and 6912 sensor

TEST PROCEDURES

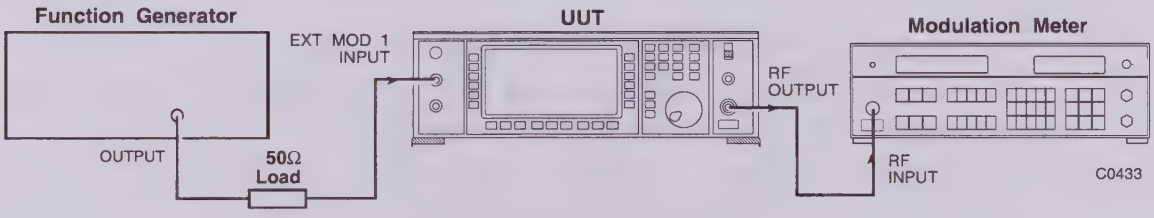

Fig. 5-1-10 External AM test set-up

(1) Connect the test equipment as shown in Fig. 5-1-10.

(2) Set the UUT to *[RF Level]* 7 dBm *[Carrier Freq.]* 400 MHz *[AM]* 80%. Then select EXT MOD 1 INPUT, DC coupled as follows:

[Select Source] [Select External] [Ext1 DC Coupling]
[SIG GEN]

(3) Set the function generator to give 1 V RMS at 1 kHz sine wave.

(4) With the modulation meter set to measure AM, set a reference using the relative function.

(5) Set the function generator to the frequencies shown in Table 5-1-12 and measure the change in external AM response which should be less than 1 dB with respect to 1 kHz.

TABLE 5-1-12 EXTERNAL AM TEST FREQUENCIES

Modulation frequency		
100 Hz	1 kHz	30 kHz
300 Hz	10 kHz	50 kHz

INTERNAL FM DEVIATION

SPECIFICATION	
Range:	1 MHz max for frequencies up to 21.09375 MHz. Up to 1% of carrier frequency for carrier frequencies above 21.09375 MHz.
Resolution:	3 digits.
Accuracy:	±5% of indication ±10 Hz at 1 kHz rate internal modulation source.
Distortion:	Less than 3% at maximum deviation for modulation frequencies up to 20 kHz.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	Minimum frequency 20 MHz	Marconi 2305 + distortion option

TEST PROCEDURES

(1) Connect the test equipment as shown in Fig. 5-1-9.

(2) Set the UUT to *[Carrier Freq.]* 21 MHz *[RF Level]* 0 dBm *[FM Devn.]* 210 kHz. Measure the FM deviation on the modulation meter.

(3) Set up a carrier frequency step on the UUT of 1 MHz as follows:

[Δ] *[Set Steps] [Carrier Step]* 1 MHz [SIG GEN]

(4) Set up an FM deviation of 500 kHz and increment the carrier frequency up to 42 MHz using the ⇑ key, measuring the deviation and distortion on the modulation meter at each step. (Note that the deviation will automatically be limited to 1% of the carrier frequency for each step.) Check that the measured deviations are within specification.

FM attenuator

(1) With the test equipment connected as in Fig. 5-1-9, set the UUT to *[Carrier Freq.]* 31.64 MHz *[RF Level]* 0dBm *[FM Devn.]* 1,260 Hz.

(2) Measure the FM on the modulation meter at the deviations indicated in Table 5-1-13. Check that the measured deviations are within specification.

TABLE 5-1-13 FM ATTENUATOR DEVIATIONS

Deviation (kHz)		
1.26	79	224
20	159	316

FM scale shape

(1) With the test equipment connected as in Fig. 5-1-9, set the UUT to *[Carrier Freq.]* 31.64 MHz *[RF Level]* 0 dBm *[FM Devn.]* 224 kHz.

(2) Referring to Table 5-1-14, measure the FM on the modulation meter at the deviations indicated.

TABLE 5-1-14 FM SCALE SHAPE DEVIATIONS

Deviation (kHz)		
224	256	289
228	261	293
233	265	298
238	270	302
242	275	307
247	279	312
252	284	316

EXTERNAL FM

SPECIFICATION	
Accuracy:	With ALC OFF the modulation is calibrated for an input level of 1.0 V PD RMS sine wave.
±1 dB bandwidth:	DC to 300 kHz. Typically 500 kHz.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	Modulation frequencies from 30 Hz to 50 kHz.	Marconi 2305
Function generator	DC to 300 kHz sine wave.	HP3325B
Frequency counter	Up to 40 MHz.	Marconi 2440

TEST PROCEDURES

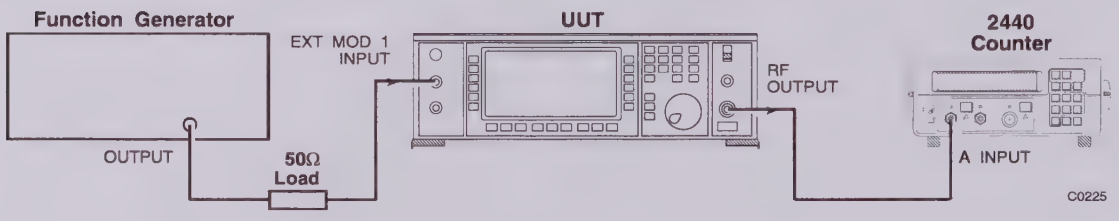

Fig. 5-1-11 External FM test set-up

(1) Connect the test equipment as shown in Fig. 5-1-10.

(2) Set the UUT to *[Carrier Freq.]* 35,468,750.1 Hz *[RF Level]* 0 dBm *[FM Devn.]* 40 kHz.

[UTIL] *[Mod'n Mode] [Comp]*
[SIG GEN] *[Select Source] [Select External]*
[Ext1 AC Coupling]
[SIG GEN] *[FM2] [Select Source] [Ext2 AC Coupling]*
[SIG GEN] 40 kHz *[FM1]* 40 kHz

The UUT will now produce FM when the external modulating source is applied to either modulation input.

(3) Set the function generator to give 1 V RMS at 1 kHz sine wave.

(4) With the modulation meter set to measure FM, set a reference using the relative function.

(5) Set the function generator to the frequencies shown in Table 5-1-15 and measure the change in external FM response which should be less than 1 dB with respect to 1 kHz.

(6) To measure the FM deviation at DC, it will be necessary to connect the test equipment as shown in Fig. 5-1-11 and DC couple the EXT MOD 1 INPUT as follows:

[Select Source] [Ext1 DC Coupling] [SIG GEN]

(7) Using the DC offset facility on the function generator, set up a voltage of +1.4142 V (i.e. $\sqrt{2}$).

(8) Measure and record the frequency indicated on the counter (F1).

(9) Set the function generator to give a DC voltage of -1.4142 V.

(10) Measure and record the frequency indicated on the counter (F2).

(11) Calculate the FM deviation using the following formula:

$$\frac{F1-F2}{2} = \text{Measured dev} = FM1$$

(12) It will now be necessary to reconnect the test equipment as shown in Fig. 5-1-10, reset the function generator to 1 kHz and measure the FM deviation on the modulation meter (FM2).

(13) Using the following formula, calculate the change in response which should be less than 1 dB:

$$20 \log_{10} \frac{FM2}{FM1}$$

(14) Transfer the function generator output to EXT MOD 2 INPUT on the UUT, select *[FM2]* and repeat (3) to (13) above.

TABLE 5-1-15 EXTERNAL FM RESPONSE FREQUENCIES

Modulating frequency (Hz)				
0	100	1,000	50,000	200,000
30	300	10,000	100,000	300,000

CARRIER FREQUENCY OFFSET

SPECIFICATION
In DC FM mode; less than ±(1 Hz +0.1% of the set deviation)

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Frequency counter	Up to 40 MHz.	Marconi 2440

TEST PROCEDURES

(1) Connect the test equipment as shown in Fig. 5-1-3.

(2) Short circuit the EXT MOD 1 INPUT.

(3) Set the UUT to *[Carrier Freq.]* 1.35 GHz *[RF Level]* 0 dBm *[FM Devn.]* 13.5 MHz, then proceed as follows:
[Select Source] [Select External] [Ext1 AC Coupling] [SIG GEN]

(4) Measure and record the carrier frequency on the counter.

(5) Set the UUT to DC coupled EXT MOD 1 INPUT as follows:
[Select Source] [Ext1 DC Coupling] [DCFM Nulling] [SIG GEN]

(6) Measure the change in carrier frequency (offset) which must be less than 13,501 Hz.

(7) Change the settings of the UUT as follows:
[Select Source] [Ext2 AC Coupling] [SIG GEN]

(8) Short circuit the EXT MOD 2 INPUT.

(9) After a 10 second settling period, measure and record the carrier frequency on the counter.

(10) Set the UUT to DC coupled EXT MOD 2 INPUT as follows:
[Select Source] [Ext2 DC Coupling] [DCFM Nulling] [SIG GEN]

(11) Measure the change in carrier frequency (offset) which must be less than 13,501 Hz.

INTERNAL PHASE MODULATION

SPECIFICATION	
Range:	Up to 10 radians in 0.01 radian steps
Accuracy:	Better than ±5% at 1 kHz
Distortion:	Less than 3% at 1 kHz modulation rate
Bandwidth:	±3 dB, 100 Hz to 10 kHz

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	Minimum frequency 20 MHz	Marconi 2305 + distortion option

TEST PROCEDURES

(1) Connect the test equipment as shown in Fig. 5-1-9.

(2) Set the UUT to *[Carrier Freq.]* 21,093,750.1 Hz *[RF Level]* 0 dBm *[ΦM]* 10 rad.

(3) Measure the phase modulation on the modulation meter which should read 10 rad ±0.5 rad.

Internal phase modulation flatness

(1) Connect the test equipment as shown in Fig. 5-1-9.

(2) Set the UUT to *[Carrier Freq.]* 21,093,750.1 Hz *[RF Level]* 0 dBm *[ΦM]* 10 rad *[Select Source: F4]* 1 kHz.

(3) Set the modulation meter to measure FM with the 50 Hz - 15 kHz LF filter selected.

(4) Measure the deviation on the modulation meter and calculate the phase modulation using the formula:

$$\Phi M = \frac{\text{FM dev (Hz)}}{\text{mod freq* (Hz)}}$$

(5) Select the modulation source frequencies as shown in Table 5-1-16 using *[Select Source: F4]* on the UUT, then enter the frequency.

(6) Measure the deviation on the modulation meter for each modulation frequency and calculate the phase modulation for each step using the formula in (4) above.

*No allowances need be made for the modulation frequency accuracy since it is derived from the crystal reference oscillator in the UUT.

(7) Using the figure recorded in (4) as a reference, calculate the change in response at each modulation frequency using the formula:

$$20 \log_{10} \frac{\text{Figure recorded in (6)}}{\text{Figure recorded in (4)}}$$

The change in response should be less than 1 dB with respect to 1 kHz.

(8) Reset the modulation frequency on the UUT to 1 kHz.

(9) Using the modulation meter set to ΦM, select DIST and measure the distortion which must be less than 3%.

TABLE 5-1-16 MODULATION SOURCE FREQUENCIES

Modulating frequency (Hz)		
100	1,000	10,000
300	3,000	

SPECTRAL PURITY

SPECIFICATION	
Harmonically related signals for RF levels up to +7 dBm:	Less than -30 dBc for carrier frequencies up to 1 GHz. Less than -27 dBc for carrier frequencies up to 2.7 GHz (2031and 2032). Less than -27 dBc for carrier frequencies up to 5.4 GHz (2032 only).
Sub-harmonics:	Less than -90 dBc for carrier frequencies up to 1.35 GHz. Less than -40 dBc for carrier frequencies up to 2.3 GHz (2031 and 2032). Less than -30 dBc for carrier frequencies up to 2.7 GHz (2031 and 2032). Less than -30 dBc for carrier frequencies up to 5.4 GHz (2032 only).
Non-harmonics:	Less than -70 dBc for carrier frequencies up to 2.7 GHz at offsets of 3 kHz or greater. Less than -64 dBc for carrier frequencies up to 5.4 GHz (2032 only).
Residual FM:	Less than 7 Hz RMS in a 0.3 to 3.4 kHz unweighted bandwidth at a 470 MHz carrier.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	Capable of measuring Residual FM less than 7 Hz	Marconi 2305
Spectrum analyzer	10 kHz to 16.2 GHz frequency coverage	Marconi 2386

TEST PROCEDURES

Residual FM

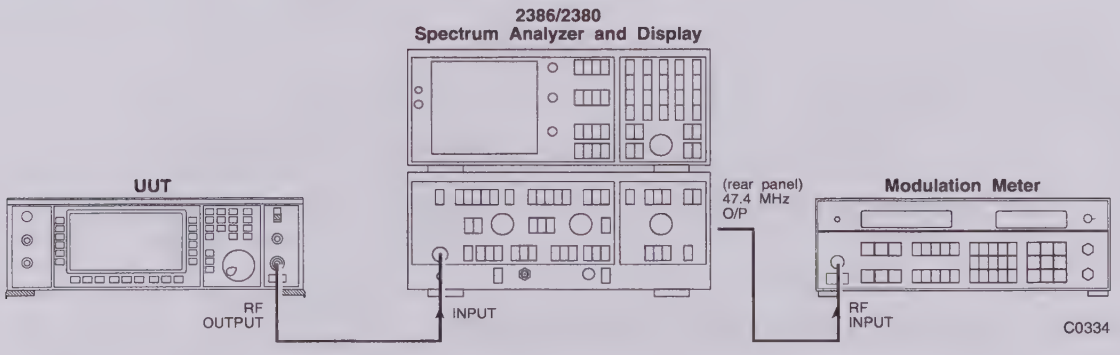

Fig. 5-1-12 Residual FM test set-up

(1) Connect the test equipment as shown in Fig. 5-1-12.

(2) Set the UUT to *[Carrier Freq.]* 470 MHz *[RF Level]* 0 dBm, modulation OFF.

(3) Set the spectrum analyzer to 470 MHz zero span.

(4) Measure the residual FM on the modulation meter in a 300 Hz to 3.4 kHz bandwidth, which must be less than 7 Hz.

Carrier harmonics

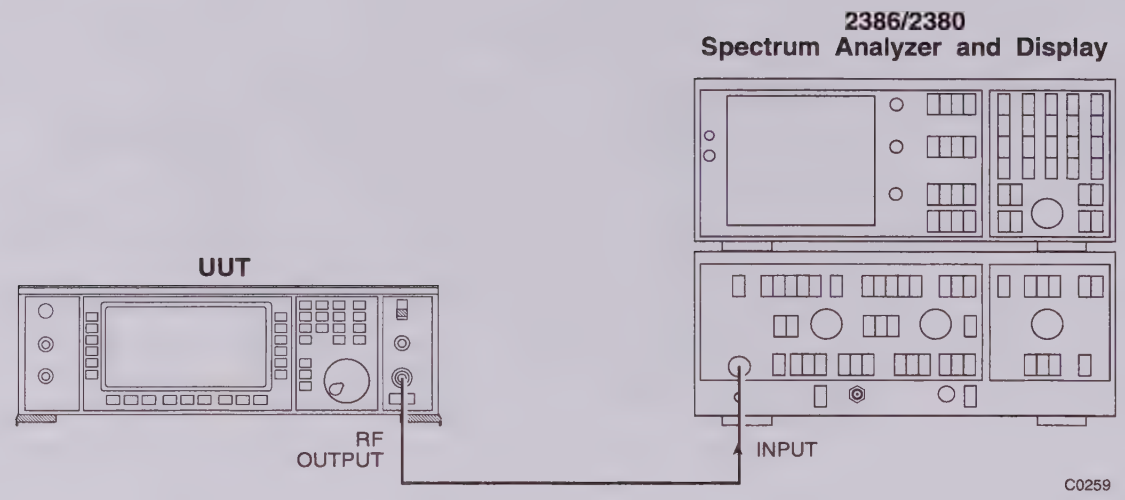

Fig. 5-1-13 Carrier harmonics test set-up

(1) Connect the test equipment as shown in Fig. 5-1-13.

(2) Set the UUT to *[Carrier Freq.]* 10 kHz *[RF Level]* 7 dBm.

(3) On the spectrum analyzer measure the 2nd and 3rd harmonics of the carrier frequency which must be less than -30 dBc for carrier frequencies up to 1 GHz and less than -27 dBc for carrier frequencies above 1 GHz.

(4) Set the UUT to the frequencies indicated in Table 5-1-17 and repeat (3) above.

TABLE 5-1-17 CARRIER HARMONIC FREQUENCIES

Carrier frequencies (Hz)			
(2030/1/2)			
10,000.0	42,187,500.1		
100,000.0	84,375,000.3	**(2031/2)**	**(2032 only)**
10,000,000.0	168,750,000.5	1,350,000,001.0	2,700,000,001.0
20,000,000.0	337,500,001.1	1,920,000,000.0	4,050,000,000.0
21,093,750.1	675,000,002.1	2,699,999,999.0	5,400,000,000.0

Carrier sub-harmonics (2031 and 2032 only)

(1) Connect the test equipment as shown in Fig. 5-1-13.

(2) Set the UUT to *[RF Level]* +13 dBm *[Carrier Freq.]* 1,350,100,000.0 Hz.

(3) Referring to Table 5-1-18, measure the level of the sub-harmonics on the spectrum analyzer at the frequencies indicated. Check that the levels are within specification.

TABLE 5-1-18 CARRIER SUB-HARMONIC FREQUENCIES

UUT carrier	Spectrum analyzer frequency (Hz)	
(2031/2)		
1,350,100,000.0	675,050,000.0	2,025,150,000.0
1,500,000,000.0	750,000,000.0	2,250,000,000.0
2,000,000,000.0	1,000,000,000.0	3,000,000,000.0
2,299,999,990.0	1,149,999,995.0	3,449,999,985.0
2,300,000,010.0	1,150,000,005.0	3,450,000,015.0
2,649,000,000.0	1,324,500,000.0	3,973,500,000.0
2,700,000,000.0	1,350,000,000.0	4,050,000,000.0
	$\frac{fc}{4}$ and $\frac{3fc}{4}$	$\frac{fc}{2}$ and $\frac{5fc}{4}$
(2032)		
2,701,000,000.0	675,250,000.0	1,350,500,000.0
	2,025,750,000.0	3,376,250,000.0
3,375,000,000.0	843,750,000.0	1,687,500,000.0
	2,531,250,000.0	4,218,750,000.0
4,050,000,000.0	1,012,500,000.0	2,025,000,000.0
	3,037,500,000.0	5,062,500,000.0
4,725,000,000.0	1,181,250,000.0	2,362,500,000.0
	3,543,750,000.0	5,906,250,000.0
5,400,000,000.0	1,350,000,000.0	2,700,000,000.0
	4,050,000,000.0	6,750,000,000.0

Non-harmonics

(1) Connect the test equipment as shown in Fig. 5-1-13.

(2) Set the UUT to *[RF Level]* 0 dBm *[Carrier Freq.]* 10 kHz.

(3) Set the spectrum analyzer to a span of 100 Hz, 10 Hz filter, and referring to Table 5-1-19, measure the level of the non-harmonics at the frequencies indicated ensuring that the levels measured are less than -70 dBc.

TABLE 5-1-19 CARRIER NON-HARMONIC FREQUENCIES

UUT carrier frequency (Hz)	Spectrum analyzer frequency (Hz)
(2030/1/2)	
10,000.0	104,867,600.0
1,000,000.0	105,857,600.0
20,000,000.0	124,857,600.0
21,093,749.0	125,951,349.0
200,000,000.0	104,867,600.0
1,350,000,000.0	1,348,322,280.0 & 1,351,677,720.0
(2031/2)	
2,700,000,000.0	2,500,000,000.0
(2032)	
5,400,000,000.0	5,200,000,000.0

SSB phase noise

SPECIFICATION	
SSB phase noise :	Less than –116 dBc /Hz (typically -122 dBc/Hz) at an offset of 20 kHz from a carrier frequency

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Phase noise measuring device	Capable of measuring phase noise of –116 dBc	Marconi L262
Signal generator	SSB phase noise at least –116 dBc at 20 kHz offset from a 470 MHz carrier signal	Marconi 2040
Spectrum analyzer	Capable of measuring 100 Hz to 100 kHz	Marconi 2382

TEST PROCEDURES

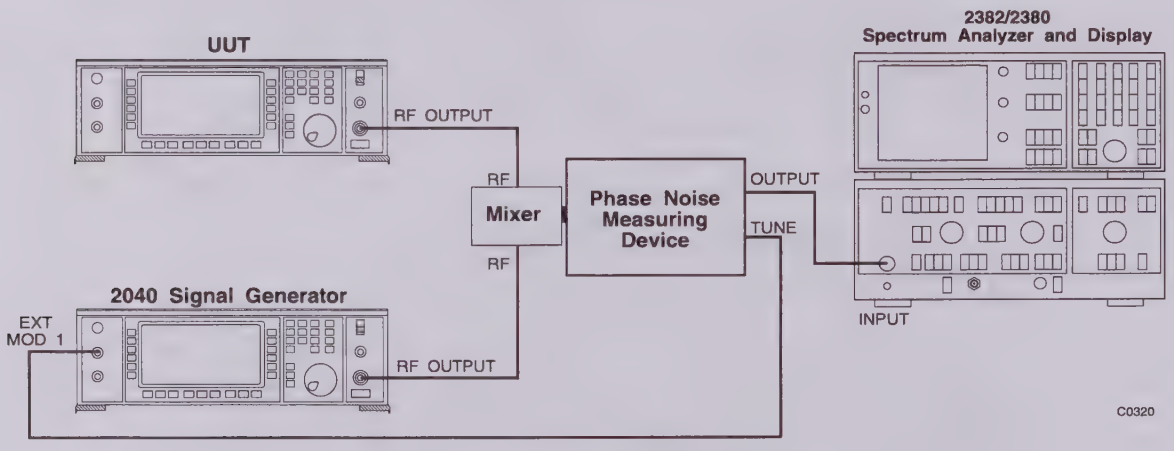

Fig. 5-1-14 SSB phase noise test set-up

(1) Connect the test equipment as shown in Fig. 5-1-14.

(2) Set the UUT to *[Carrier Freq.]* 470 MHz *[RF Level]* 7 dBm, modulation to OFF.

(3) Using the phase noise measuring device, measure SSB phase noise at a 20 kHz offset which should be less than –116 dBc.

LAST COMPLETE CHECK DATE

On completion of the adjustment routine or of a calibration check, the date can be recorded. To do this, unlock the instrument to level 2, select the Calibration Utilities Menu, then press the *[Checks Complete]* key. This will result in the *Last Complete Check* date being updated to the current date.

CALIBRATION DUE DATE

The date of the next calibration check can be entered from the calibration utilities menu by pressing the *[Set Next Cal Date]* key. On reaching the calibration date, the instrument will display an error message indicating that it should be returned for a calibration check. The recommended calibration interval is 2 years.

REAL TIME CLOCK BATTERY

The real time clock uses a lithium battery to provide uninterrupted power regardless of whether the instrument is switched on or off. Although the estimated life of this battery is 5 years, customers may wish to replace it every 2 years.

Chapter 5-1
Appendix A

ACCEPTANCE TESTING SECOND MODULATION OSCILLATOR OPTION

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MODULATION OSCILLATORS

The following tests are for a 2030, 2031 or 2032 with the 2nd modulation oscillator fitted.

SPECIFICATION	
Frequency range:	0.1 Hz to 500 kHz
Accuracy:	Equal to the frequency standard accuracy
Resolution:	0.1 Hz
Distortion:	Less than 0.1% THD at frequencies up to 20 kHz sine wave mode

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Frequency counter	10 Hz to 500 kHz	Marconi 2440
Audio analyzer	Capable of measuring down to 0.03% THD from 100 Hz to 20 kHz	HP 8903B Rhode & Schwarz UPA 3

TEST PROCEDURES

Modulation oscillator frequencies

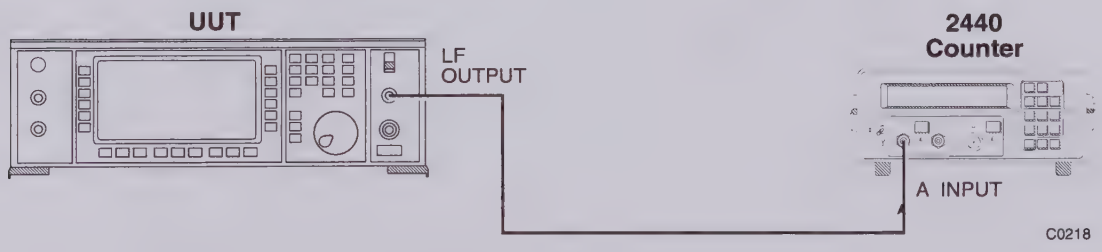

Fig. 5-1-A-1 Modulation oscillator frequencies test set-up

(1) Connect the test equipment as shown in Fig. 5-1-A-1.

(2) To enable both the modulation oscillators on the UUT, it will be necessary to carry out the following procedure:-

Press the following sequence of keys:

[UTIL] *[Mod'n Mode] [Comp]* **[SIG GEN]** *[Source Freq:]*

The frequencies of the first modulation oscillator may now be entered.

(3) Referring to Table 5-1-A-1, check that the oscillator frequencies can be selected correctly and are within specification.

(4) To monitor the second modulation oscillator, enter the following:

[FM2] [Select Source] [Select Internal] [Internal F1]
[LF] *[Mod2 Source]* **[SIG GEN]** *[Source Freq:]*

The frequencies of the second modulation may now be entered.

(5) Repeat (3) above.

TABLE 5-1-A-1 MODULATION OSCILLATOR FREQUENCIES

Modulation oscillator frequencies (Hz)	
10.00	279,620.20
139,810.10	500,000.00

Modulation oscillator distortion

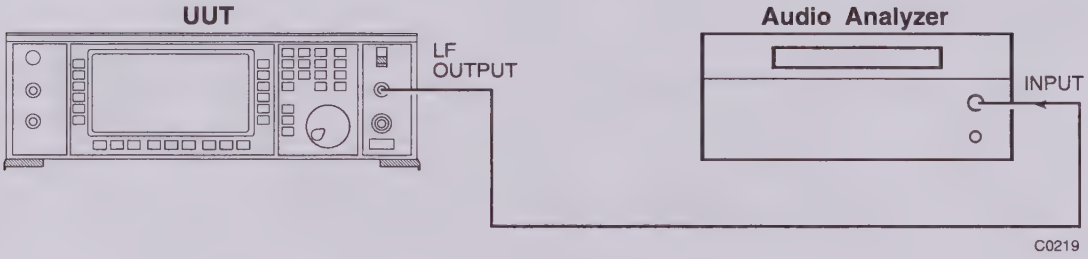

Fig. 5-1-A-2 Modulation oscillator distortion test set-up

(1) Connect the test equipment as shown in Fig. 5-1-A-2.

(2) Set the UUT such that the first modulation oscillator may be tested (refer to 'Modulation oscillator frequencies' step (2) above).

(3) Check that the distortion measured on the audio analyzer at the frequencies indicated in Table 5-1-A-2 is less than 0.1%.

(4) Set the UUT such that the second modulation oscillator may be tested (refer to 'Modulation oscillator frequencies' step (4) above).

(5) Repeat (3) above.

TABLE 5-1-A-2 DISTORTION FREQUENCIES

Modulation oscillator frequencies	
100 Hz	10 kHz
1 kHz	20 kHz

LF OUTPUT

SPECIFICATION	
Level accuracy:	±5% for levels above 50 mV, ±10% for levels from 500 µV to 50 mV (with a load impedance >10 kΩ)
Frequency response:	Typically better than 1 dB from 0.1 Hz to 300 kHz

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Digital multimeter	DC to 300 kHz, 1 mV to 5 V	Datron 1061A
Audio analyzer	Capable of measuring 0.5 mV ±3% and levels at 10 Hz	HP8903B Rhode & Schwarz UPA3

TEST PROCEDURES

Level accuracy

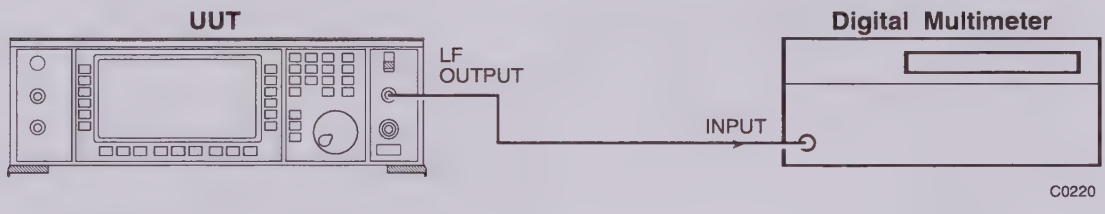

Fig. 5-1-A-3 Level accuracy test set-up

(1) Connect the test equipment as shown in Fig. 5-1-A-3.

(2) Set the UUT to give an LF output of 5 V at 1 kHz by entering the following:

[LF] *[LF Gen] [LF Freq]* 1 kHz *[LF Level]* 5 V

(3) The level measured on the digital multimeter should read 5 V ±0.25 V.

(4) Check the LF output of the UUT at the levels indicated in Table 5-1-A-3. Check that the measured levels are within specification.

TABLE 5-1-A-3 LF OUTPUT LEVELS

LF output levels (V)		
5.0000	0.1000	0.0050
2.0000	0.0500	0.0020
1.0000	0.0200	0.0010
0.5000	0.0100	*0.0005
0.2000		

*For the last measurement it will be necessary to use the audio analyzer. Connect the test equipment as shown in Fig. 5-1-A-4.

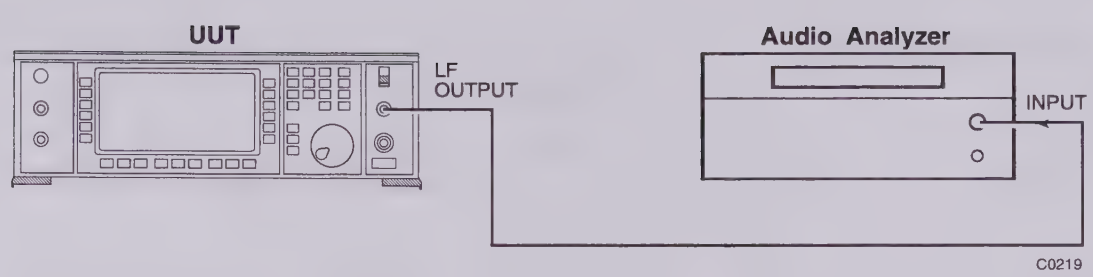

Fig. 5-1-A-4 LF output levels test set-up for 0.0005 V

Frequency response

(1) Connect the test equipment as shown in Fig. 5-1-A-2.

(2) Set the UUT to give an LF output of 1 V at 1 kHz on the first modulation oscillator (refer to 'Level accuracy' above).

(3) Reference this level on the audio analyzer using the dB relative function.

(4) Set the modulation oscillator to the frequencies given in Table 5-1-A-4 measuring the difference from the reference in (3) above which should be less than 1 dB.

(5) Set the UUT to give an LF output of 1 V at 1 kHz on the second modulation oscillator (refer to 'Level accuracy' above).

(6) Repeat (3) and (4) above.

TABLE 5-1-A-4 TEST FREQUENCIES

Test frequencies		
10 Hz	1 kHz ref	70 kHz
30 Hz	10 kHz	100 kHz
100 Hz	30 kHz	300 kHz

AM SCALE SHAPE

SPECIFICATION	
Range:	0 to 99% in 0.1% steps
Accuracy:	For carrier frequencies up to 1 GHz, ±4% of setting, ±1% depth. Usable to 2.7 GHz **(2031)**. Usable to 5.4 GHz **(2032)**.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	1.5 MHz to 1 GHz Accuracy: better than 1.1%	Marconi 2305 + distortion option

TEST PROCEDURES

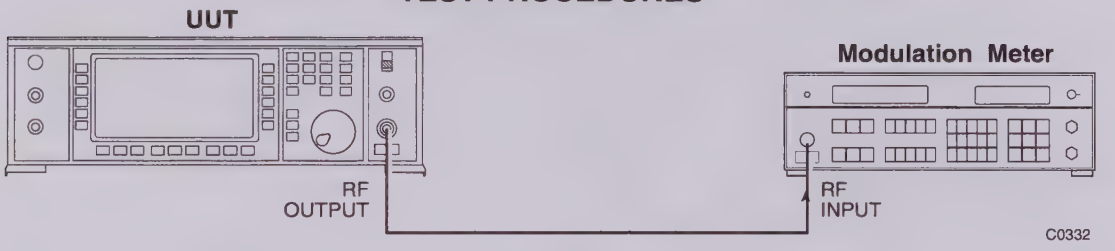

Fig. 5-1-A-5 AM scale shape test set-up

(1) Connect the test equipment as shown in Fig. 5-1-A-5.

(2) Set the UUT to *[RF level]* 0 dBm, *[Carrier freq.]* 100 MHz, then enter the following:

[UTIL] *[Mod'n mode] [Comp]*
[SIG GEN] *[AM]* 1%

(3) Measure the AM on the modulation meter at the depths shown in Table 5-1-A-5. Check that the measured AM depth is within specification.

(4) Set the UUT by entering the following:

[AM1 ON/OFF] [AM2] [Select Source] [Select internal]
[Internal F4] **[SIG GEN]** 1%

(5) Repeat (3) above.

TABLE 5-1-A-5 AM DEPTHS

AM depth (%)									
1	10	31	34	37	39.1	39.4	39.7	40	70
2	20	32	35	38	39.2	39.5	39.8	50	80
5	30	33	36	39	39.3	39.6	39.9	60	85

FM SCALE SHAPE

SPECIFICATION	
Range:	1 MHz max for frequencies up to 21.09375 MHz. Up to 1% of carrier frequency for carrier frequencies above 21.09375 MHz
Resolution:	3 digits
Accuracy:	±5% of indication ±10 Hz at 1 kHz rate internal modulation source

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	Minimum frequency 20 MHz	Marconi 2305 + distortion option

TEST PROCEDURES

(1) With the test equipment connected as in Fig. 5-1-A-5, set the UUT to *[Carrier freq.]* 31.64 MHz, *[RF level]* 0 dBm then enter the following:

[UTIL] *[Mod'n Mode] [Comp]*
[SIG GEN] *[FM2] [Select Source] [Select Internal]*
[Internal F4]
[SIG GEN] *[FM1]*

(2) The deviation for FM1 can now be entered. Referring to Table 5-1-A-6, measure the FM on the modulation meter at the deviations indicated. Check that the measured deviation is within specification.

(3) Set FM1 to 0 Hz deviation and select *[FM2]*.

(4) The deviation for FM2 can now be entered. Repeat (2) above.

TABLE 5-1-A-6 DEVIATION FREQUENCIES

Deviation (kHz)		
224	256	289
228	261	293
233	265	298
238	270	302
242	275	307
247	279	312
252	284	316

Chapter 5-1
Appendix B

ACCEPTANCE TESTING
PULSE MODULATION OPTION

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PULSE MODULATION

The following tests are for a 2030, 2031 or 2032 with the pulse modulation option fitted.

SPECIFICATION	
Maximum input level:	+5 V.
Minimum ON Level:	+3.5 V.
Maximum OFF level:	+1.0 V.
OFF/ON ratio :	Greater than 70 dB at the carrier frequency. Typically greater than 80 dB.
Additional output level error :	Less than 0.5 dB.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Power meter	±0.1 dB from 30 kHz to 2.7 GHz.	Marconi 6960A and 6912 sensor
Spectrum analyzer	Frequencies up to 1.4 GHz. Capable of measuring <-70 dBm.	Marconi 2386
Function generator	DC capability.	HP3325B

TEST PROCEDURES

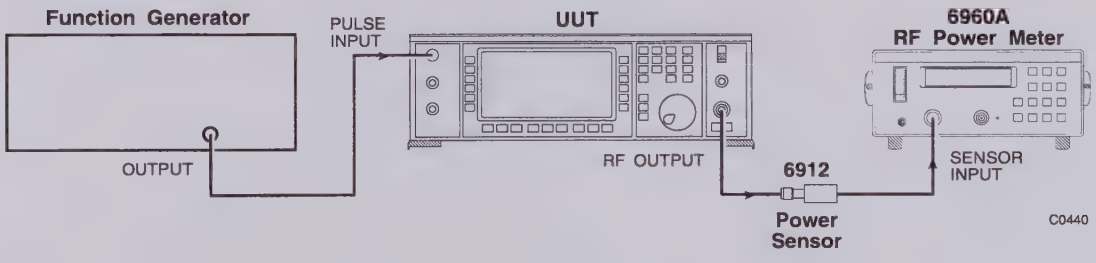

Fig. 5-1-B-1 Levels test set-up

Minimum 'ON' level

(1) Connect the test equipment as shown in Fig. 5-1-B-1.

(2) Set the UUT to *[RF level]* 0 dBm *[Carrier freq.]* 10 MHz and *[Pulse Mod.]*.

(3) Set the function generator to give +3.5 V DC. The 0 dBm level should now appear on the power meter.

Maximum 'OFF' level

(4) Set the function generator to give 1.0 V DC. The 0 dBm level should now disappear from the power meter.

Additional level error

(1) Set the UUT to *[Carrier Freq.]* 1 MHz, *[RF level]* 0 dBm.

(2) Measure and record the RF level indicated on the power meter (P1).

(3) Set the UUT to *[Pulse Mod.]*

(4) Set the function generator to give +5 V DC.

(5) Measure and record the RF level indicated on the power meter (P2).

(6) The difference between P1 and P2 must be less than 0.5 dBm.

ON/OFF ratio

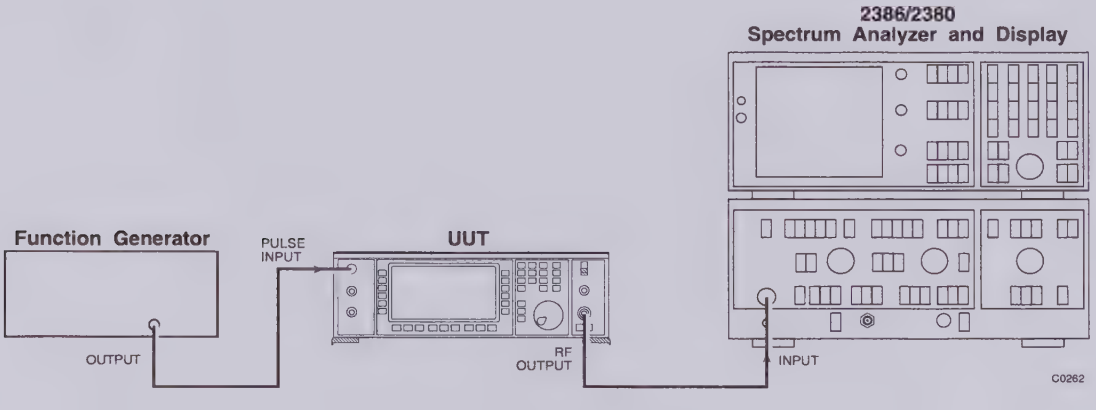

Fig. 5-1-B-2 ON/OFF ratio test set-up

(1) Connect the test equipment as shown in Fig. 5-1-B-2.

(2) Set the UUT to *[Carrier Freq.]* 11 MHz, (RF level) 0 dBm, and *[Pulse Mod].*

(3) Set the function generator to give +5 VDC.

(4) Set the spectrum analyzer to 11 MHz, span/div 10 kHz, and, using the 'Peak Find' facility, measure the amplitude of the carrier signal and record as (P1).

(5) Set the function generator to give 0 V DC.

(6) Measure the amplitude of the carrier signal and record as (P2). The difference between P1 and P2 must be greater than 70 dB.

(7) Repeat (3) to (6) above for the UUT and spectrum analyzer frequencies shown in Table 5-1-B-1.

TABLE 5-1-B-1 ON/OFF RATIO CARRIER FREQUENCIES

Carrier frequencies		
11 MHz	675 MHz	1.349,999 GHz
111 MHz	1 GHz	

Chapter 5-1

Appendix C

ACCEPTANCE TESTING HIGH OUTPUT POWER OPTION

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The following tests are for a 2030 fitted with the +19 dBm option (high output power).

RF OUTPUT LEVEL

SPECIFICATION	
Level range:	-138 dBm to +19 dBm.
Accuracy :	±1.2 dB from 10 kHz to 1.35 GHz.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
RF power meter	±0.1 dB from 30 kHz to 2.7 GHz.	Marconi 6960A and 6912 sensor

TEST PROCEDURES

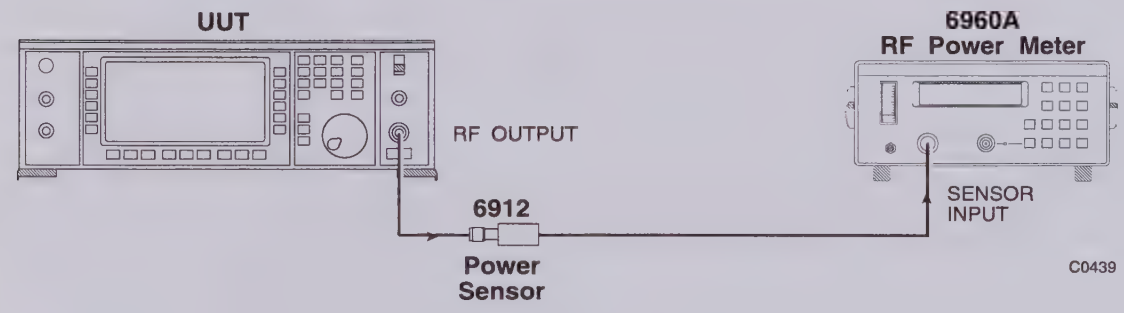

Fig. 5-1-C-1 RF output and ALC linearity test set-up

(1) Connect the test equipment as shown in Fig. 5-1-C-1.

(2) Set the UUT to *[RF level]* 6.1 dBm, *[Carrier freq.]* 30 kHz.

(3) Check that the output level is within ±1.2 dBm at the frequencies shown in Table 5-1-C-1.

(4) Set the UUT RF output to 13 dBm and repeat (3) above.

(5) Set the UUT RF output to 19 dBm and repeat (3) above.

TABLE 5-1-C-1 RF OUTPUT TEST FREQUENCIES

Frequency (MHz)	
0.03	675
0.1	825
75	975
225	1125
375	1275
525	1350

ALC LINEARITY

(1) Connect the test equipment as shown in Fig. 5-1-C-1.

(2) Set the UUT to *[Carrier freq.]* 2.5 MHz, *[RF level]* 6 dBm.

(3) Increment the RF output of the UUT in 1 dB steps up to 18 dBm and in 0.1 dBm steps up to 19 dBm, measuring the RF level at each step.

(4) Set the UUT carrier frequency to 500 MHz and repeat (3) above.

(5) Set the UUT carrier frequency to 1.35 GHz and repeat (3) above.

CARRIER HARMONICS

SPECIFICATION	
Harmonically related signals:	Less than -27 dBc for carrier frequencies up to 1.35 GHz.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer	10 kHz to 4.1 GHz frequency coverage.	Marconi 2386

TEST PROCEDURES

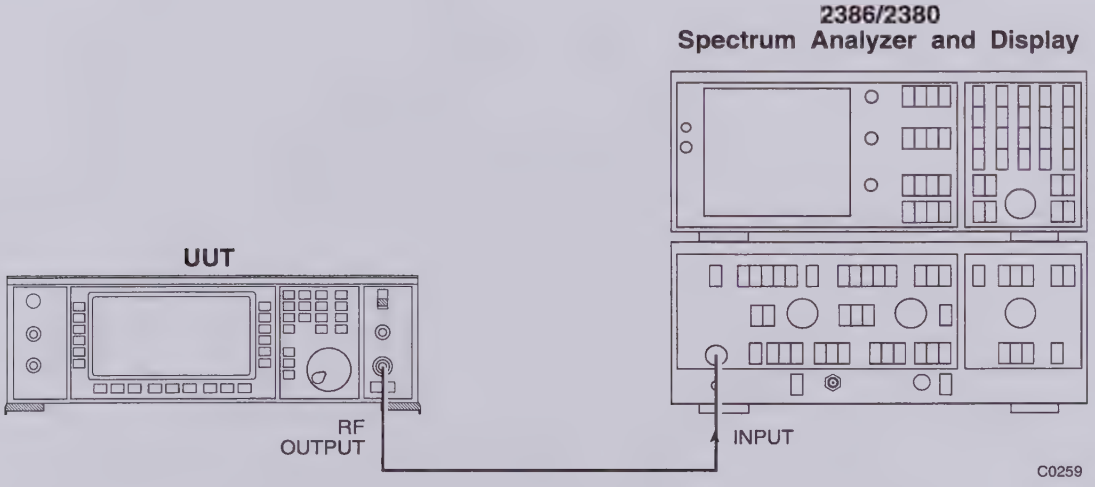

Fig. 5-1-C-2 Carrier harmonics test set-up

(1) Connect the test equipment as shown in Fig. 5-1-C-2.

(2) Set the UUT to *[Carrier freq.]* 10 kHz, *[RF level]* 0 dBm.

(3) On the spectrum analyzer measure the 2nd and 3rd harmonics of the carrier frequency which must be less than -27 dBc.

(4) Set the UUT to the frequencies indicated in Table 5-1-C-2 and repeat (3) above.

TABLE 5-1-C-2 CARRIER HARMONIC FREQUENCIES

Carrier frequencies (Hz)	
10,000.0	42,187,500.1
100,000.0	84,375,000.3
10,000,000.0	168,750,000.5
20,000,000.0	337,500,001.1
21,093,750.1	675,000,002.1

Annex A
OPTION 005 GMSK Bt 0.3

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GENERAL DESCRIPTION

This option adds GMSK (Gaussian Minimum Shift Keying) modulation at a bit rate of 270.833 kHz to the 2030 series. This modulation is used by the GSM (Global System for Mobile communications) and UK PCN (Personal Communication Network) system

Front panel connectors provide external modulation inputs for clock, data and envelope control. The wide band FM input is available for doppler simulation.

Facilities are provided for modulation by an internal data source and for editing the data. The front panel connectors provide outputs for clock and data in this mode.

Instruments may be locked together via the SYNC connectors to allow multi-carrier signals to be generated.

A 2030 or 2031 Signal Generator fitted with the GMSK option, conforms to the 2030 series specification when in GSM mode (performance is not affected in other modes) except as follows:

PERFORMANCE DATA

CARRIER FREQUENCY

Range	2030: 10 MHz to 1.34675 GHz. 2031: 10 MHz to 2.69675 GHz.

RF OUTPUT

Range:	0 dBm to -144 dBm.
Accuracy:	Less than ±2 dB for carrier frequencies 10 MHz to 2 GHz.
Output VSWR:	As for 2030 series for levels below -6 dBm.

SPECTRAL PURITY

Non-harmonic output

GMSK signals are generated by mixing a local oscillator with a 3.25 MHz IF signal carrying the GMSK signal. Additional signals are present at the local oscillator frequency, image frequency and frequencies equivalent to the harmonics of the IF mixed with the local oscillator.

FREQUENCY STANDARD

In GSM mode an input or output at 1, 5, 10 or 13 MHz is available. On external standard input sensitivity is 0 dBm.

OUTPUT VSWR	Specification applies to output levels less than -6 dBm.
RF LEAKAGE	Specification applies for carrier frequencies up to 2 GHz.

GMSK MODULATION

Modulation type

GMSK Bt 0.3 to GSM recommendation 05.04.

Modulation accuracy

Phase accuracy as defined by GSM 05.05 - 4.6 is 1° RMS, 3° peak.

Data coding

Selectable as uncoded, or differentially coded to GSM recommendation 05.04 - 2.3 for internal or external modulation.

INTERNAL MODULATION

An internal data source provides a Traffic Channel format superframe hierarchy. Individual slots may be null data, fixed data, or contain (2^9-1) Pseudo Random Binary Sequence (PRBS) data as defined in CCITT rec. V.52. Successive slots contain 156, 156, 156, 157 bits when on internal clock or external 'integer' clock. An internal data source provides data output on the DATA and clock on the CLOCK connectors. Internal data can either be edited from the front panel and stored or entered using he GPIB.

The RF envelope may be ramped up and down to GSM 05.05 annex 2 and GSM 05.05 - 4.2.2.

The internal data generator can be used with an external clock as in 'External Modulation'.

Data storage

Data in the data generator can be stored and edited from the front panel or via the GPIB. Data store sizes are:

100 slots of which 2 are defined as null (SLOT 0) and PRBS (SLOT 99)
100 frames containing any of the stored slots in any order
100 multiframes containing any of the stored frames in any order
40 superframes containing any of the stored multiframes in any order.

Internal modulation outputs

Data output:	TTL compatible.
Clock output:	TTL compatible.

EXTERNAL MODULATION

Clock and data input at TTL compatible levels. Data must be valid on the falling edge of the clock input.

Data input level:	TTL compatible.
Clock input level:	TTL compatible.
Clock input frequency:	270.833 kHz ±25 parts/10^6 or a clock of the same bit rate but including one clock period of 1 1/4 bits per slot.
Envelope input impedance:	15 kΩ nominal.
Doppler FM input impedance:	50 Ω.

ENVELOPE CONTROL

Controlled by selectable constant internal level, or from the external ENVELOPE input. External envelope levels are 0 V for off, +1 V for specified RF level. The RF output voltage varies linearly with applied voltage.

Input rise time:	Less than 4 µs.
Off slot suppression:	Better than -70 dBc at 0 V.

MODULATION SENSE

Output frequency can be set to upper or lower sideband. Modulation sense can be inverted.

SYNCHRONIZATION

Instruments may be synchronized by use of the SYNC input/output. One instrument in Master mode sources a bit clock and the SYNC signal. The SYNC signal goes active low for one bit during the transition of the internal data from slot 7, bit 156 to slot 0, bit 0. Instruments in Slave mode use Clock and Sync signals to remain in synchronism.

Synchronization input/output :	Open collector TTL 2 mA pull-up, active low, bidirectional.

DIMENSIONS AND WEIGHT

Height	Width	Depth	Weight
152 mm	425 mm	525 mm	19.0 kg
6 in	16.6 in	20.5 in	42 lb

GMSK OPERATION

INTRODUCTION

This chapter explains how to use Option 005 GMSK Bt 0.3 when fitted to a 2030 or 2031 Signal Generator. Familiarity with the normal operation of the instrument is assumed.

FRONT PANEL

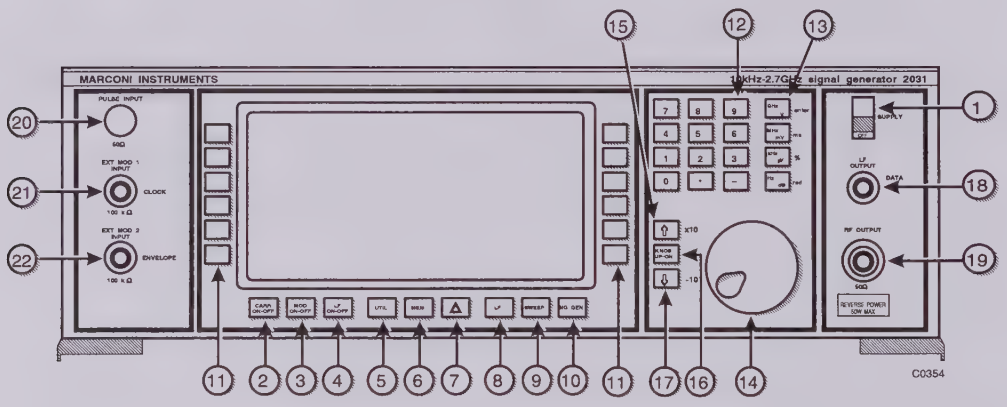


Fig. A-1 2031 series front panel with Option 005

(1)	SUPPLY	Switches the AC supply voltage on and off.
(2)	CARR ON-OFF	Enables or disables the carrier frequency.
(3)	MOD ON-OFF	Enables or disables the modulation.
(4)	LF ON-OFF	Switches the low frequency output on and off.
(5)	UTIL	Displays the utilities menu.
(6)	MEM	Displays the memory store/recall menu.
(7)	Δ	Displays the total shift menu.
(8)	LF	Displays the LF and monitor menus.
(9)	SWEEP	Displays the sweep status menu.
(10)	SIG GEN	Displays the main menu.
(11)	SOFT KEYS	Twelve function keys change notation as the menu changes.
(12)	NUMERICAL KEY PAD	For changing the value of a selected parameter. Minus sign and decimal point are included.
(13)	UNITS KEYS	Determine the units of set parameters and terminate the numerical entry.
(14)	CONTROL KNOB	When enabled, adjusts the value of the selected parameter.

(15)	⇑ × 10	When knob disabled, increments a selected parameter. When knob enabled, increases knob sensitivity by value of ten.
(16)	KNOB UP-DN	Switches between control knob and ⇑⇓ keys.
(17)	⇓ ÷ 10	When knob disabled, decrements a selected parameter. When knob enabled, decreases knob sensitivity by value of ten.
(18)	LF OUTPUT or DATA	BNC socket provides a low impedance output at the frequency selected at the *LF GENERATOR MENU* or monitors the modulating signal. In GSM mode the connector is used for data input or output.
(19)	RF OUTPUT	50 Ω N type socket with reverse power protection.
(20)	PULSE	50 Ω BNC socket (if fitted) accepts a pulsed signal.
(21)	EXT MOD 1 or INPUT CLOCK	100 kΩ BNC socket. An independent input which allows an external modulation signal to be applied. In GSM mode it is used for clock input/output.
(22)	EXT MOD 2 or INPUT ENVELOPE	100 kΩ BNC socket, similar to (21). In GSM mode the connector is used for external envelope control.

REAR PANEL

The following facilities are available on the rear panel, see Fig. A-2.

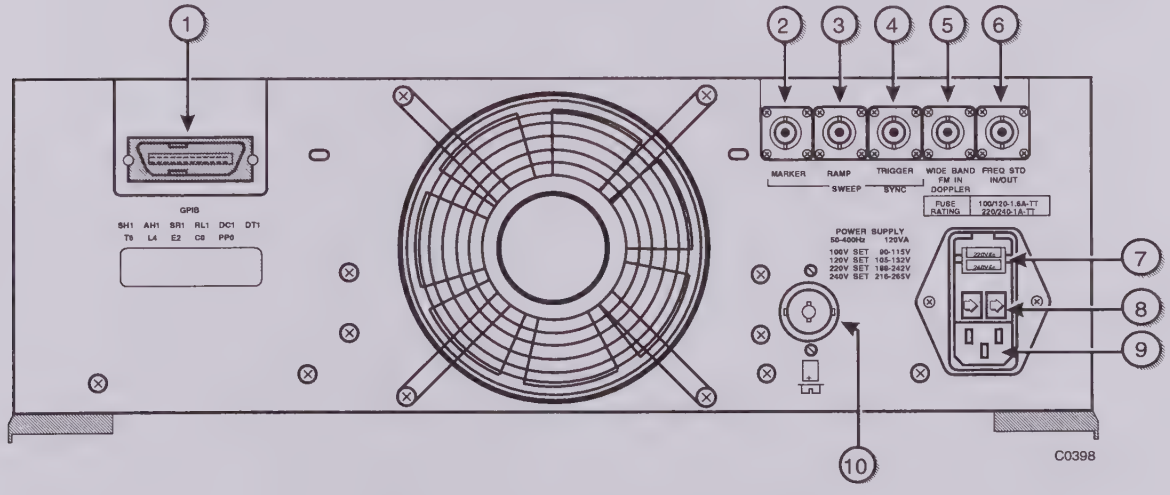


Fig. A-2 2031 rear panel with Option 005

(1)	GPIB	24 pin socket accepts standard IEEE connector to allow remote control of the instrument.
(2)	SWEEP MARKER	BNC socket supplies sweep marker.
(3)	SWEEP RAMP	BNC socket provides a ramp output at 0 to 10 V peak-to-peak.
(4)	SWEEP TRIGGER or SYNC	BNC socket provides access for a trigger input or SYNC input/output in GSM Mode.
(5)	WIDE BAND FM IN or DOPPLER	BNC socket accepts a wide bandwidth FM signal into 50 Ω with a typical bandwidth of 10 MHz. In GSM mode the connector may be used for doppler simulation.
(6)	FREQ STD IN/OUT	BNC socket for standard frequencies at 1, 5 or 10 MHz at TTL levels. In GSM mode an additional standard of 13 MHz can be accepted and generated.
(7)	VOLTAGE SELECTOR	Removable cover reveals barrel which can be rotated to select the required voltage range.
(8)	FUSES	AC fuses rated at 1.6 A TT (double time lag) for the 100 to 120 V range and 1 A TT (double time lag) for the 220 to 240 V range.
(9)	AC SUPPLY INPUT	3 pin plug integral with voltage selector and fuse holders. Mates with supply lead socket.
(10)	BATTERY HOLDER	Houses battery for real time clock.

GSM MODE

The GSM mode of operation is an additional modulation mode. To enter this mode press the [UTIL] key and select the *[Mod'n Mode]* from the Utilities Selection Menu (see Fig. A-3).

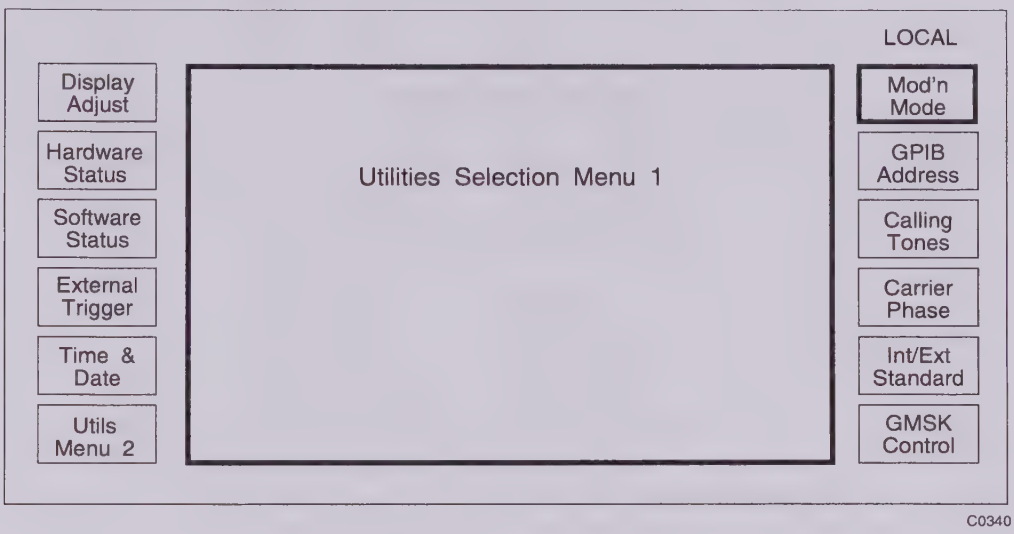


Fig. A-3 Utilities selection menu 1

Use the *[GMSK]* key shown in Fig. A-4 to select the GSM mode of operation.

Note...

If the GSM modulation mode is not selected, the GSM data and controls can be edited and modified but GSM signals cannot be generated.

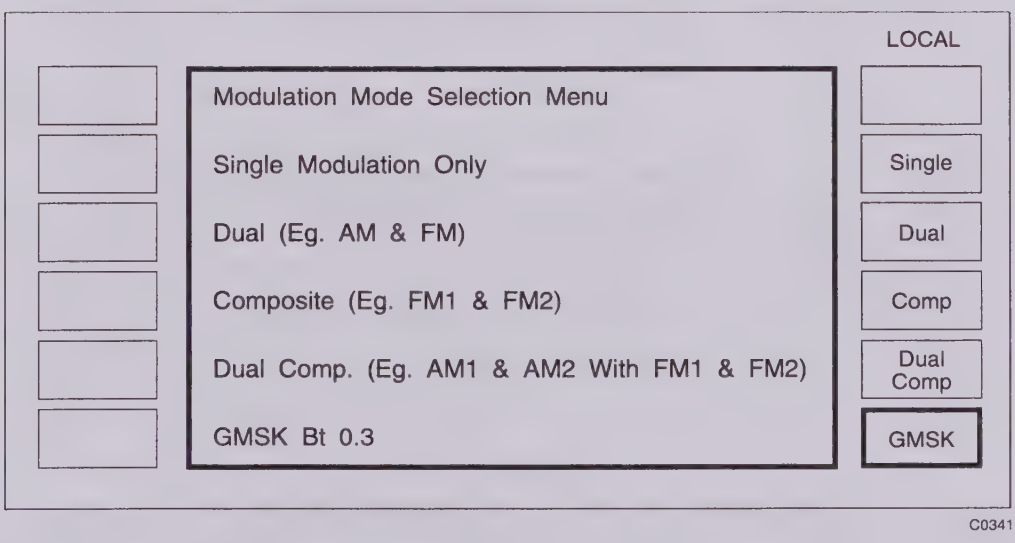


Fig. A-4 Modulation mode selection with GMSK

GMSK CONTROL

To set the GMSK control function, return to the Utilities Selection Menu 1 shown in Fig. A-3 and press the *[GMSK Control]* key to obtain the display shown in Fig. A-5.

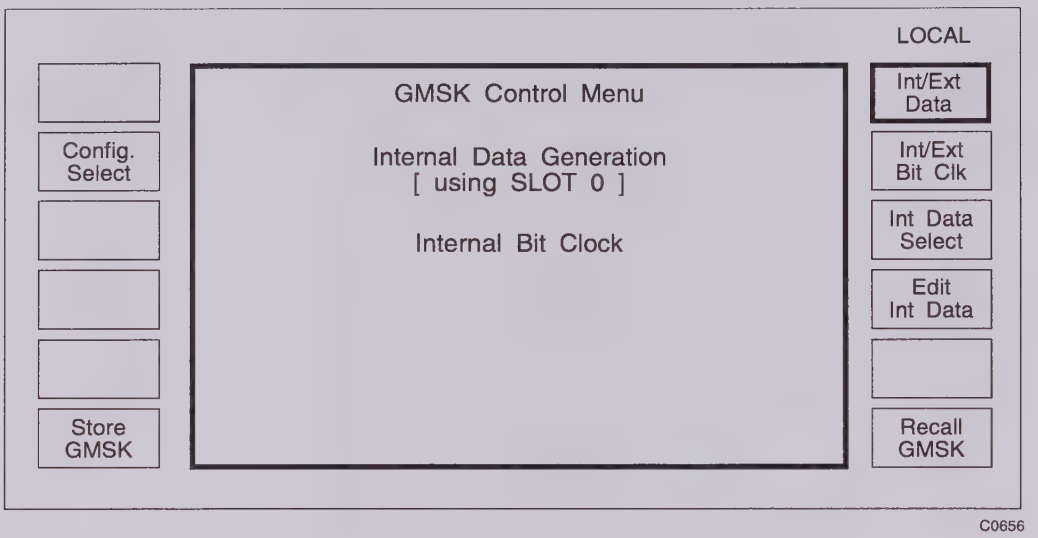


Fig. A-5 GMSK control menu with external data selected

Alternatively the [*GMSK Control*] key can be accessed by pressing the [SIG GEN] key to obtain the menu shown in Fig. A-6 (provided the GMSK modulation mode has been enabled).

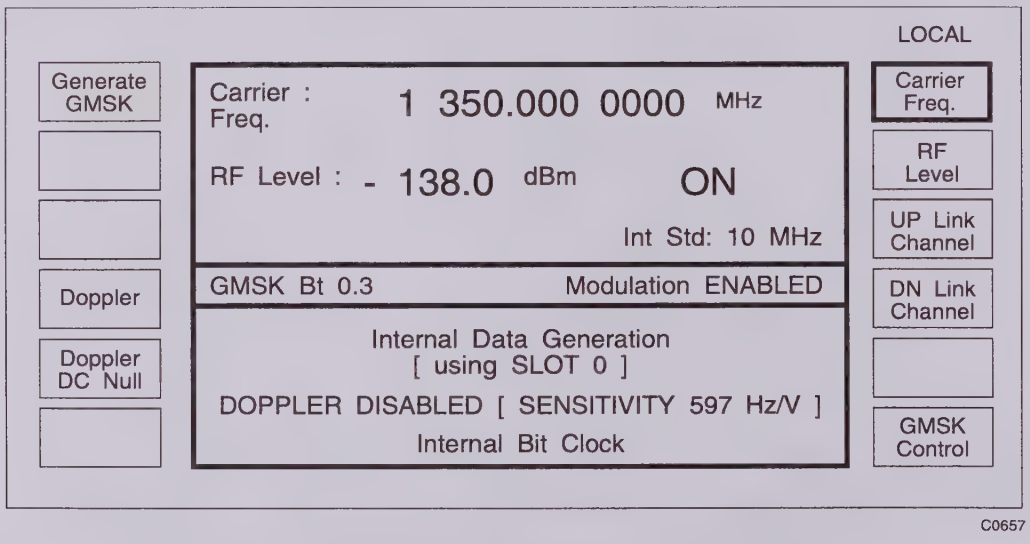


Fig. A-6 Sig. Gen. menu with internal data selected

Configuration select

Configuration select is used to set the way in which the GSM generator interacts with internal and external control signals. To set up the GSM configuration, press the *[Config. Select]* key shown in Fig. A-5 to obtain the menu shown in Fig. A-7.

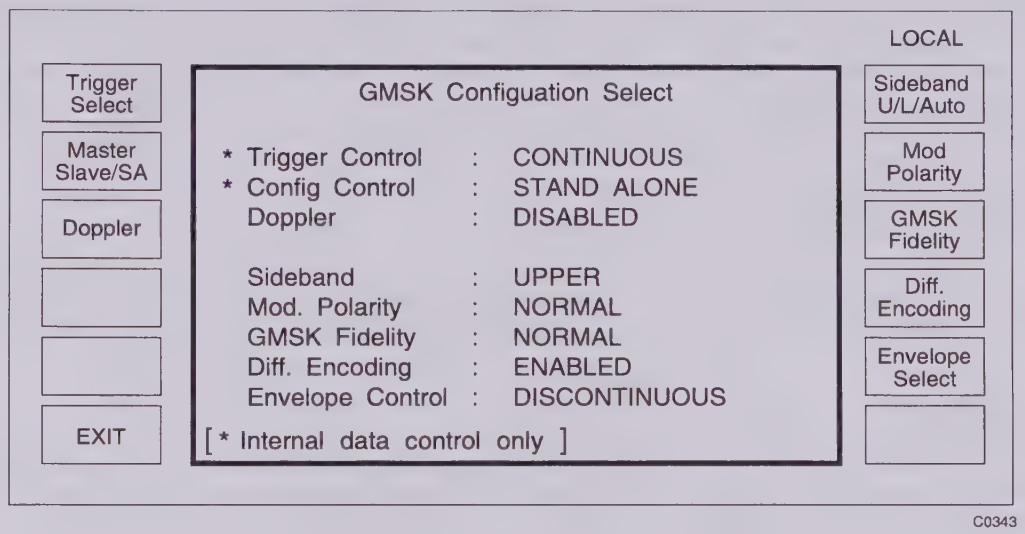


Fig. A-7 GMSK configuration selection menu

Trigger control

The *[Trigger Select]* key can be set to continuous or single trigger operation. In continuous mode the data from the internal data generator is repeated continuously while in the single mode the data is only generated once.

Configuration control

When using the internal data generator the instrument may be set to stand alone, master or slave mode using the *[Master/Slave/SA]* key. When *STAND ALONE* is selected the instrument responds in the normal way to GPIB or keyboard commands. When *MASTER* is selected the instrument generates a clock output from the CLOCK connector and a synchronizing signal from the SYNC connector on the rear panel. By connecting the clock and sync signals to a generator set to the slave mode the master will control the timing of the data generator in the slave instrument such that if the two RF signals are compared their slot/frame structures are in synchronism. This allows the generator to be used in applications requiring two or more sources of GMSK signal.

Doppler

With Doppler set to *ENABLED* the DOPPLER input on the rear panel of the instrument may be used to frequency modulate the carrier using an external source to simulate the effect of Doppler frequency shifts. The DOPPLER input can also be used to add FM signals to simulate the effect of receiving signals with a GMSK phase error .

The sensitivity, in Hz/V, of the DOPPLER input is displayed on the Sig. Gen. Menu (Fig. A-6). The sensitivity is carrier frequency dependent since it uses the same input as Wideband FM and the instrument sets the sensitivity to be close to 500 Hz/V or the minimum sensitivity available (at 2 GHz the minimum sensitivity is typically 1200 Hz/V).

Sideband

The GMSK signals are generated by frequency converting a 3.25 MHz IF signal up to the required output frequency. Local oscillator frequencies at 3.25 MHz offset and an image frequency at 6.5 MHz offset of equal amplitude to the wanted signal are generated. The *[Sideband U/L/Auto]* key can be used to select the wanted GMSK signal and where the image frequency occurs. If *UPPER* sideband is selected the image and local oscillator frequencies are below the GMSK frequency. If *LOWER* sideband is selected the image and local oscillator frequencies are above the GMSK frequency. If *AUTO* is selected the generator automatically selects upper or lower sideband generation so as to generate the unwanted signals towards the centre of the GSM or PCN band.

Modulation polarity

The *[Mod. Polarity]* key can be used to select either *NORMAL* modulation sense or *INVERSE* modulation sense. *INVERSE* can be used to simulate IF signals where the modulation sense has been reversed in frequency converting the input RF signal.

GMSK fidelity

The *[GMSK Fidelity]* key can be used to select either *NORMAL* which provides accurate GMSK Bt 0.3 modulation or *CORRUPT* which results in the generation of a signal with a RMS phase trajectory error of typically 5° RMS (±10° peak). *CORRUPT* can be used to test the tolerance of a receiver to GMSK errors.

Differential encoding

The GSM specification requires that the data is differentially encoded. This is accomplished by setting the Differential Encoding to *ENABLED*. The differential encoder can be *DISABLED* when it is more convenient to work with uncoded data (e.g. when working with a basic demodulator).

Envelope select

The Envelope Control can be set to CONTINUOUS or DISCONTINUOUS using the [Envelope Select] key.

With CONTINUOUS envelope selected the RF signal is maintained at a constant level with no amplitude shaping being present.

When DISCONTINUOUS envelope is selected and an external data/clock source is being used, the RF Envelope is controlled using the ENVELOPE input on the front panel. The level is linearly controlled with 0 Volts producing no output and +1 V producing the nominal RF output. When using the internal data generator on DISCONTINUOUS envelope control, the RF output is suppressed at the start and end of each slot and remains suppressed on null slots.

Exit

Using the *[EXIT]* key on the GMSK Configuration Menu will return the operator to the GMSK Control Menu.

STORE/RECALL GMSK

The GMSK control settings can be stored or recalled using the *[Store GMSK]* and *[Recall GMSK]* keys on the GMSK Control Menu (Fig. A-5). The stores contain the settings of all the information on the GMSK Control Menu, including those set by the GMSK *[Configuration Select]*, but do not include other parameters displayed on the Sig Gen menu (e.g. carrier frequency, level). The facility provides a simple means of storing and recalling modulation settings without changing the carrier frequency and level. Valid store numbers are 0 to 19.

Note...

If a full store and recall facility is required, including carrier frequency and level, then the Full Store and Full Recall facilities accessed by the [MEM] key should be used. When a setting is Recalled the Full store includes the Modulation Mode setting (i.e. whether it is in GSM mode) but not those parameters stored by the *[Store GMSK]* key.

EXTERNAL DATA/CLOCK OPERATION

To generate GMSK Bt 0.3 modulation from an external source a data and clock source are required. The RF envelope can be set to continuous or external control via the ENVELOPE input using the Configuration Selection menu. External data mode is selected from the GMSK Control Menu using the *[Int/Ext Data]* key. In external data mode the clock input is used to phase lock the 13 MHz data generator clock and the RF output frequency is phase locked to this standard. If the clock is not applied *Error 06 : VCXO Out of Lock* or *Error 43 : No External Bit Clock* will appear at the top of the display.

Data must be valid on the falling (negative) edge of the clock input.

The clock frequency must either be 270.833 kHz, the GSM bit rate, or have a clock sequence with 155 successive periods corresponding to the GSM bit rate followed by 1 period corresponding to 1 1/4 bits of the GSM bit rate. The instrument will automatically lock on to either signal.

The presence of a 1 1/4 bit period will introduce a phase discontinuity on the RF signal at a time corresponding to approximately 3 bits in advance of the 1 1/4 bit period. The position of this phase discontinuity can be retarded in time using hardware links. Assuming the factory set condition is used and the 1 1/4 bit period is on bit 156, the phase discontinuity is in the guard bits and has no effect on a receiver.

Note...

In GSM mode the DATA input is used as the LF OUTPUT. This output is a low impedance source and care should be taken in connecting it to sensitive external loads. The LF OUTPUT is internally protected.

Setting the output carrier

The carrier output frequency and level are set by pressing the [SIG GEN] key to obtain the display shown in Fig. A-8. Carrier frequency and RF level can be selected and entered in the normal way.

Note...

In GSM mode the RF level extended hysteresis function is not available.

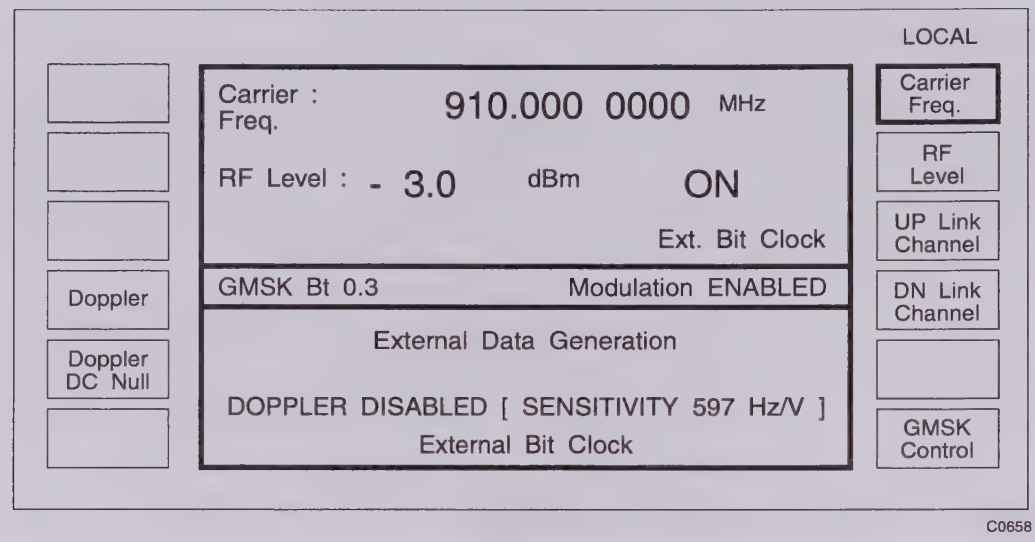


Fig. A-8 Sig. Gen. menu in GSM mode with external data/clock

In addition the carrier frequency can be edited directly by entering the channel number specified in the GSM and PCN standards. For GSM the usable channels are numbered 1 to 124 and for PCN are numbered 512 to 885. The channel frequencies are entered using *[UP Link Channel]* or *[DN Link Channel]* keys followed by the channel number and the [enter] key to set the mobile to base station and base station to mobile frequencies respectively.

INTERNAL DATA GENERATION MODE

The 2030 series GMSK option includes an internal data generator which obtains data from any of 100 slots. The slot information can be stored in a non-volatile store. The slots can be assembled into a frame structure and up to 100 of these frames may be stored. A 26 frame multiframe can in turn be assembled from any of the stored frames and up to 100 multiframes stored. The multiframes can be assembled into a 51 multiframe structure and up to 40 superframes can be stored. Any of slots/frames/multiframes/superframes may be used as the data source. The data can be generated once only or continuously repeated.

Data can be edited and stored from the front panel or from the GPIB.

The internal data generator can also be used with an external clock source as described under 'External Data/Clock Operation'.

Internal data selection

From the GMSK Control Menu, Fig. A-9, select *[Int Data Select]* to obtain the GMSK Internal Data Select menu shown in Fig. A-10. The *[SLOT], [FRAME], [MULTIFRAME], [SUPERFRAME]* keys may be used to select the data as slot, frame multiframe or superframe.

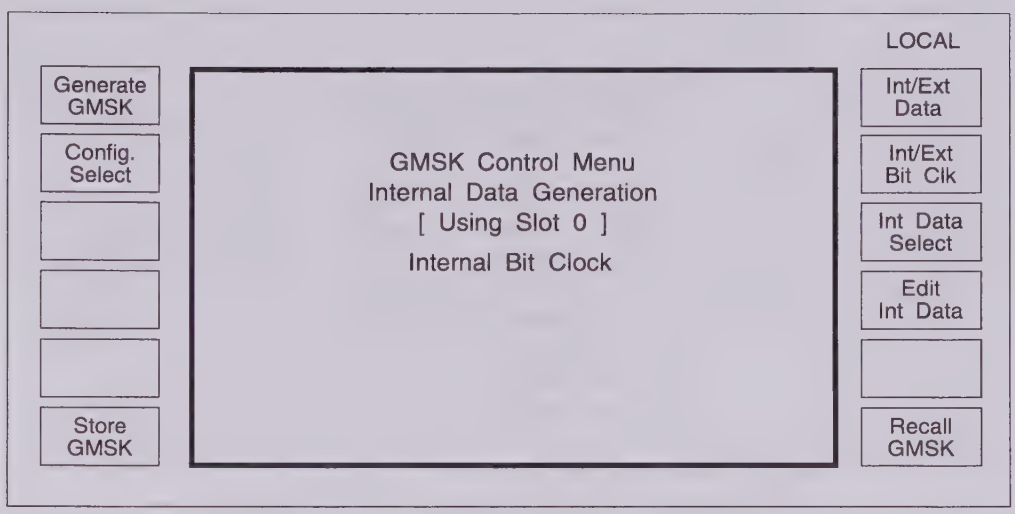


Fig. A-9 GMSK control menu

If slot data is selected the display shows the slot information as shown in Fig. A-10. The data is displayed as logical '1's and '0's. The first line of data shows the 3 tail bits, the second and third lines show 57 bits of data, the fourth line is a control bit, the fifth line is the midamble training sequence, the sixth line a control bit, the seventh and eighth lines the second block of 57 data bits and the ninth line consists of 3 tail bits.

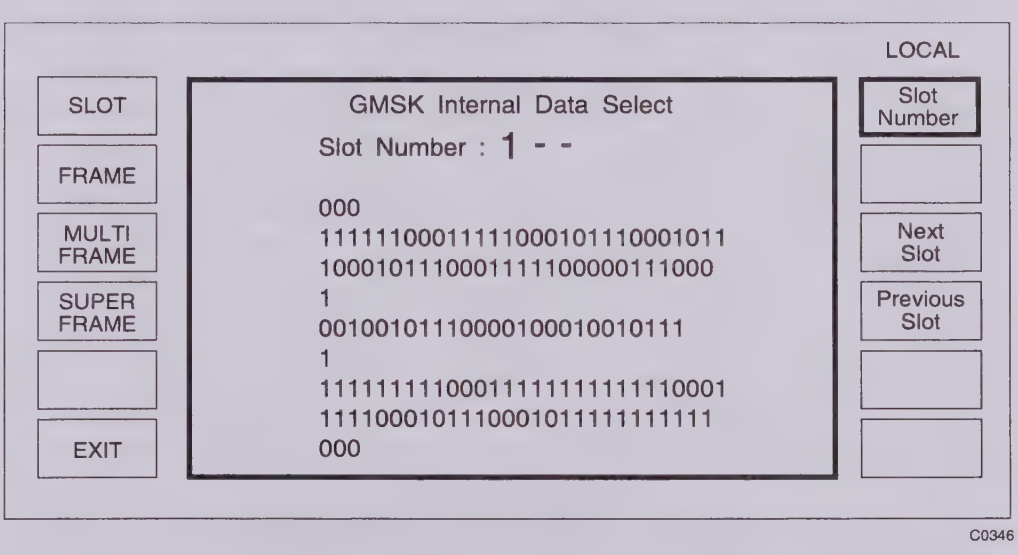


Fig. A-10 GMSK internal data selection menu with slot selected

Any slot number can be selected using *[Slot Number]* followed by a one or two digit number and terminated with the [enter] key. The *[Next Slot]* and *[Previous Slot]* keys provide a means of looking at slot information in the adjacent slot stores.

If frame data is required, selecting *[FRAME]* from the GMSK Internal Data Selection menu will result in the frame display shown in Fig. A-11. The stored slot number (S0 to S99) contained in the 8 slots (0 to 7) making up a frame is displayed. Any frame number can be selected and displayed using the *[Frame Number]* key followed by a one or two digit number and terminated with the [enter] key.

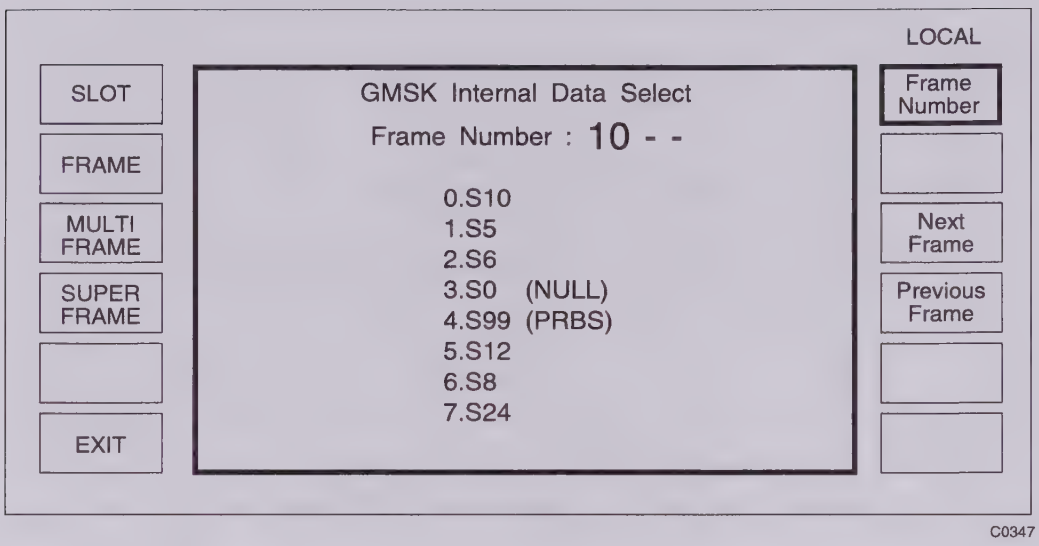


Fig. A-11 GMSK internal data select menu with frame selected

If *[MULTI FRAME]* is selected the data is displayed as shown in Fig. A-12. The multiframe data is shown as 26 frames (0 to 25) and the frame selected in each location is displayed (F0 to F99). Different multiframes can be selected using the *[Frame Number]* key.

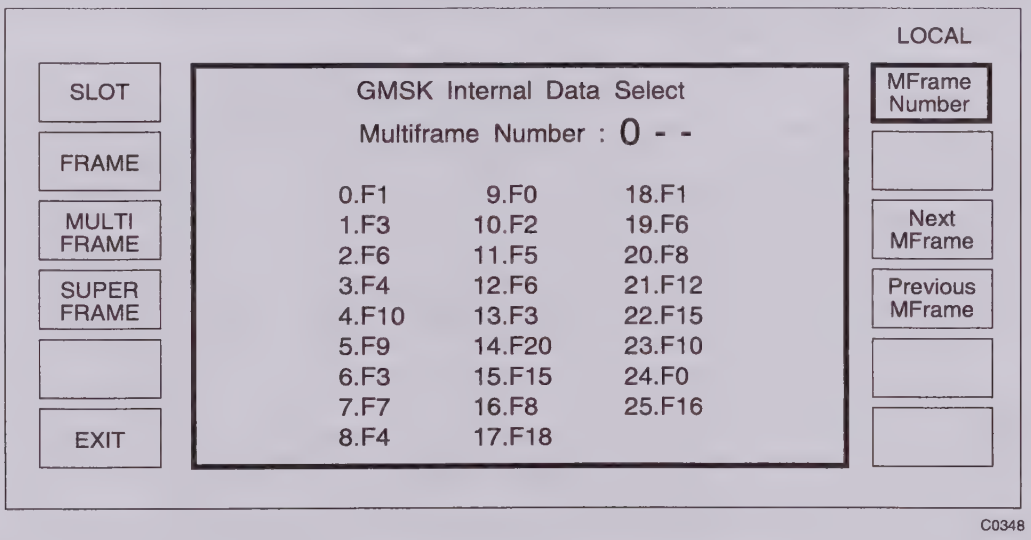


Fig. A-12 GMSK internal data select menu with multiframe selected

If *[SUPER FRAME]* is selected the data is displayed as shown in Fig. A-13. A superframe of 51 multiframes (0 to 40) is displayed with the multiframe data (MF0 to MF99) in each location.

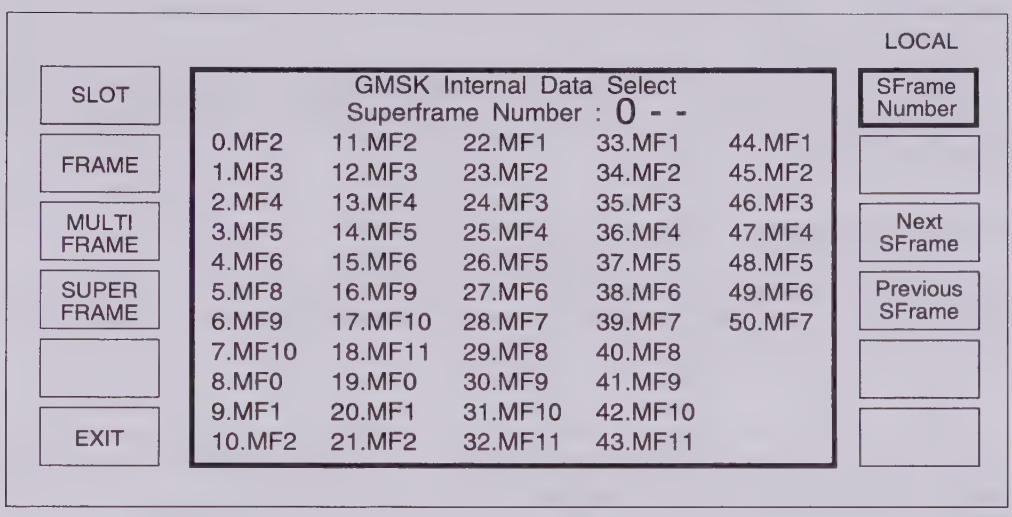


Fig. A-13 GMSK internal data selection menu with superframe selected

When the required data has been selected, selecting the *[EXIT]* key will return to the GMSK Control Menu and selecting *[Generate GMSK]* will result in the instrument generating the selected GMSK data. On selecting *[Generate GMSK]* the key will be replaced by a *[Halt GMSK]* key and selecting this key will stop GMSK generation.

Alternatively to display the carrier frequency and RF level when the data has been selected, press [SIG GEN]. The instrument display will be as shown in Fig. A-14. Selecting *[Generate GMSK]* will result in the instrument generating the selected GMSK data.

The carrier frequency and level can be entered from the Sig Gen Menu with internal data selected in the same way as with an external data source (see page A-13).

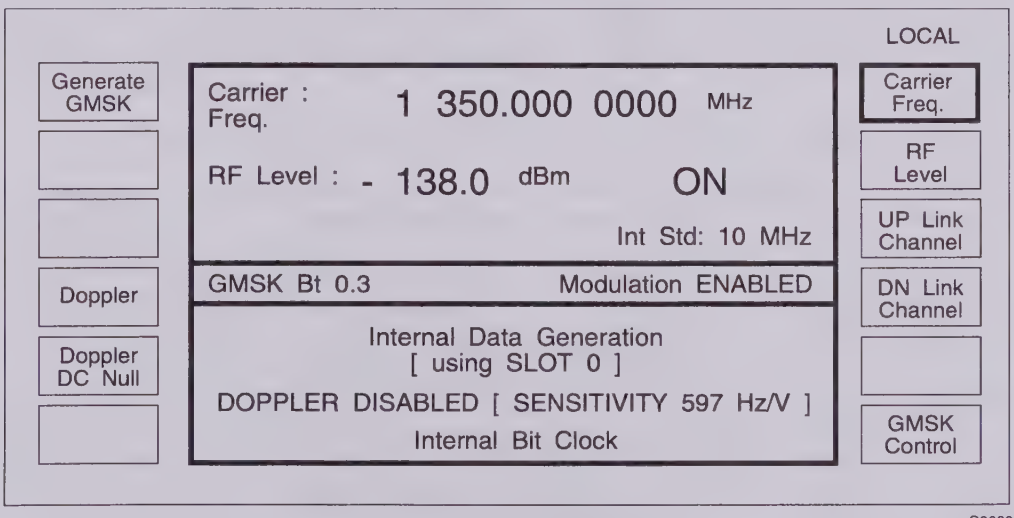


Fig. A-14 Sig. Gen. menu with internal data selected

Modulation ON/OFF

Pressing of the [MOD ON-OFF] key underneath the display will enable or disable the GMSK modulation. When modulation is disabled the generator reverts to normal mode and the GMSK module is bypassed.

External clock/internal data

The internal data generator can be used with an external clock with the same format clock as described under 'External data/clock operation'. To select an external clock press *[Int/Ext Bit Clk]* on the *GMSK Control Menu* (see Fig. A-9).

Notes...

In order to operate from an external bit clock, the configuration control (see 'Configuration control' above) must be set to either stand alone or slave mode. In master mode a bit clock output is generated on the CLOCK connector.

If external clock is selected but not applied, no error message is displayed.

DATA EDITOR

The data in a slot, frame, multiframe or superframe can be edited with the editor. To edit data select *[Edit Int Data]* on the GMSK Control Menu in Fig. A-9. The operating principle of the editor is similar whichever data (slot, frame, multiframe or superframe) is being edited. The data is displayed in the same format as shown under 'Internal Data Selection'. If a slot is being edited the data is displayed as shown in Fig. A-15. Having selected the data to be edited pressing the *[EDIT]* key will result in the display shown in Fig. A-16. A cursor box will appear in the position which is to be edited. Selecting *[Set Bit to 0]* or *[Set Bit to 1]* will enter a 0 or 1 at that point and the cursor will then automatically increment to the next bit. The cursor position can be moved by selecting *[Bit Number]* followed by a one to three digit number then pressing the [enter] key. *[Next Bit]*, *[Previous Bit]* can be used to increment or decrement the cursor position.

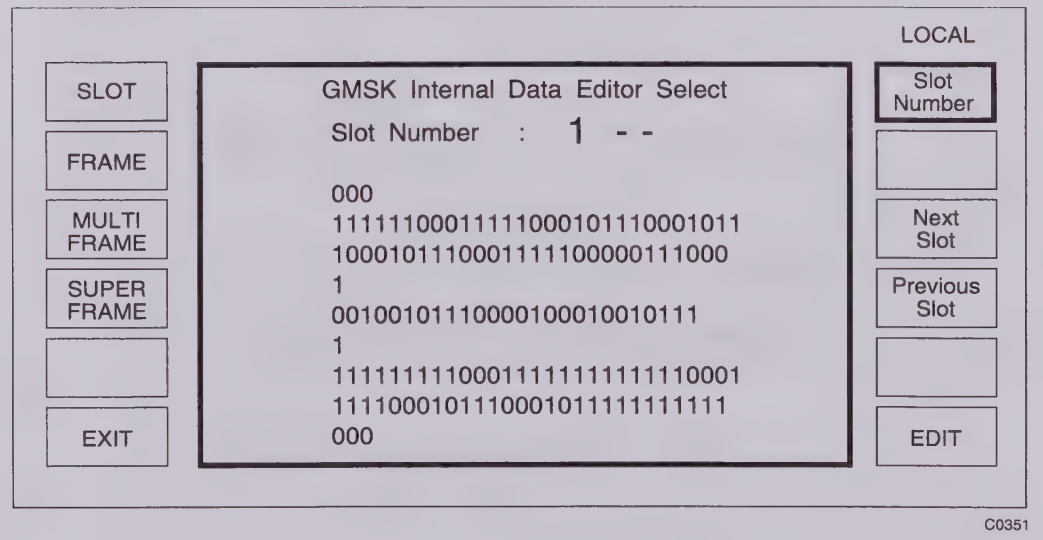


Fig. A-15 Data editor with slot editing selected

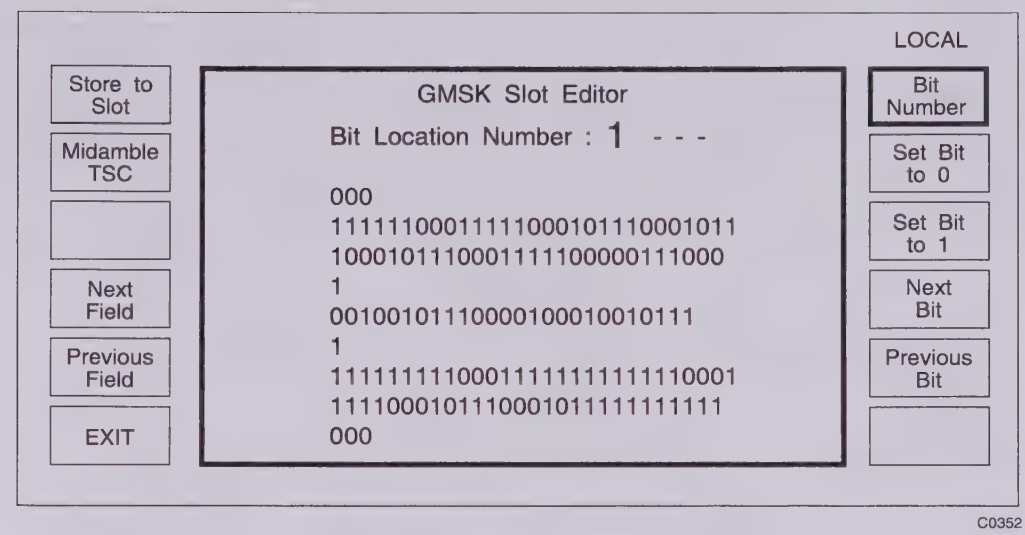


Fig. A-16 Editing slot data

The midamble training sequence (Midamble TSC) can be directly entered by selecting *[Midamble TSC]* followed by a number (0 to 7 as defined in the GSM standard) then pressing the [enter] key.

The cursor position can also be changed to the start of a field by using the *[Next Field], [Previous Field]* keys. The fields are defined as the first tail bits, first data field, first control bit, midamble, second control bit, second data field, and final tail bits. The guard bits are not programmable and are set to 1.

When the data has been edited selecting *[Store to Slot]* followed by a one or two digit number and then pressing the [enter] key will result in the data being stored to the appropriate slot number (S1 to S98).

It should be noted that slots S0 and S99 are pre-defined slots and cannot be edited. S0 is defined as a NULL slot and S99 as a pseudo random bit sequence (PRBS) corresponding to that required of the GSM standard.

To return to the GMSK Internal Data Editor Select menu select the *[EXIT]* key.

Frame editor

Selecting *[FRAME]* on the GMSK Internal Data Editor will result in the display shown in Fig. A-17. The slot position being edited is displayed as S-- and the location and data are displayed at the top of the page. The location to be edited can be entered using *[Location Number]* and the data at that point can be entered after selecting *[Location Data]*.

The edited data can be stored to any frame number by selecting the *[Store to Frame]* key followed by a one or two digit number then pressing the [enter] key.

To return to GMSK Internal Data Editor Menu select *[EXIT]*.

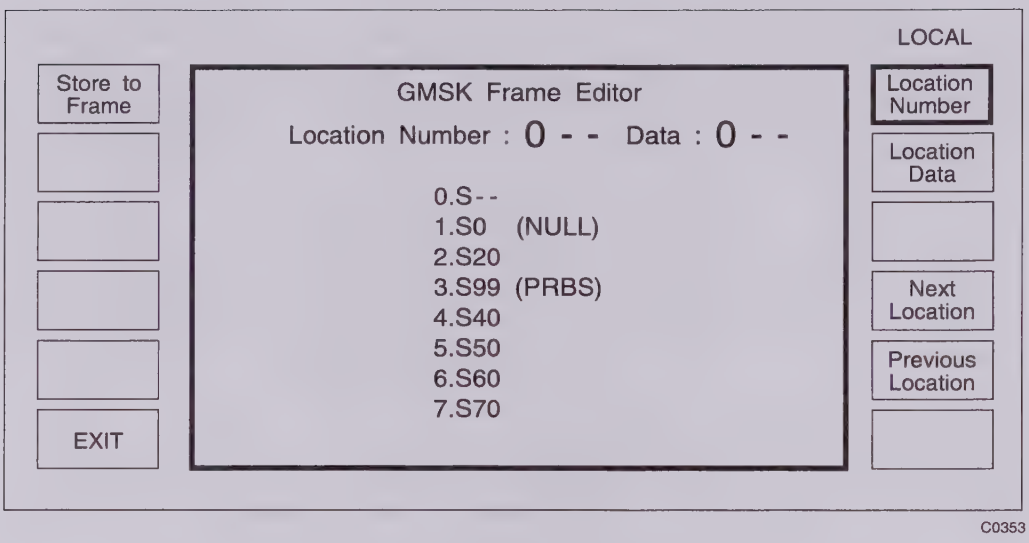


Fig. A-17 GMSK frame editor menu

Multiframe/superframe editor

Editing multiframes and superframes is accomplished in the same way as editing frames. The data is displayed in a similar format to that shown in Fig. A-12 and Fig. A-13. Information is stored in the same way as for frames. Multiframes can be stored as Multi Frame (MF) 0 to 99 and superframes as Super Frame (SF) 0 to 39.

FREQUENCY STANDARD

Instruments with the GSM option fitted can either accept a frequency standard of 13 MHz from an external source or generate a 13 MHz standard via the FREQ STD INT/EXT connector on the rear panel in addition to those available on other versions of the 2030 series. Selection is via the Utilities page 1 using the *[Int/Ext Standard]* key

The output frequency of the GSM signal is the sum of the local oscillator frequency and the 3.25 MHz IF carrying the modulation. The local oscillator and 3.25 MHz IF are locked in accordance with Table A-1 below

TABLE A-1 FREQUENCY LOCKING

INT/EXT STD set to:	Bit clock set to:	2030 local oscillator locked to:	3.25 MHz IF locked to:	INT STD O/P locked to:
INT	INT	Internal OCXO	Internal OCXO	Internal OCXO
INT 1, 5 or 10 MHz	EXT	Internal OCXO	Bit clock	Internal OCXO
INT 13 MHz	EXT	Internal OCXO	Bit clock	Bit clock
EXT	INT	External std	External std	N/A
EXT	EXT	External std	Bit clock	N/A

POWER UP OPTIONS

In some circumstances it may be desirable for the instrument to switch on with a GMSK signal being generated. To set an instrument to recall to GMSK setting on power up select the Utilities 2 Menu. Unlock the instrument using *[Lock & Unlock]* key to Level 1. The default password for Level 1 is 1234 (see page 3-1-36). Return to the Utilities 2 Menu and select the *[Power Up Option]* key to obtain the menu shown in Fig. A-18 when *[Memory Power Up]* is selected.

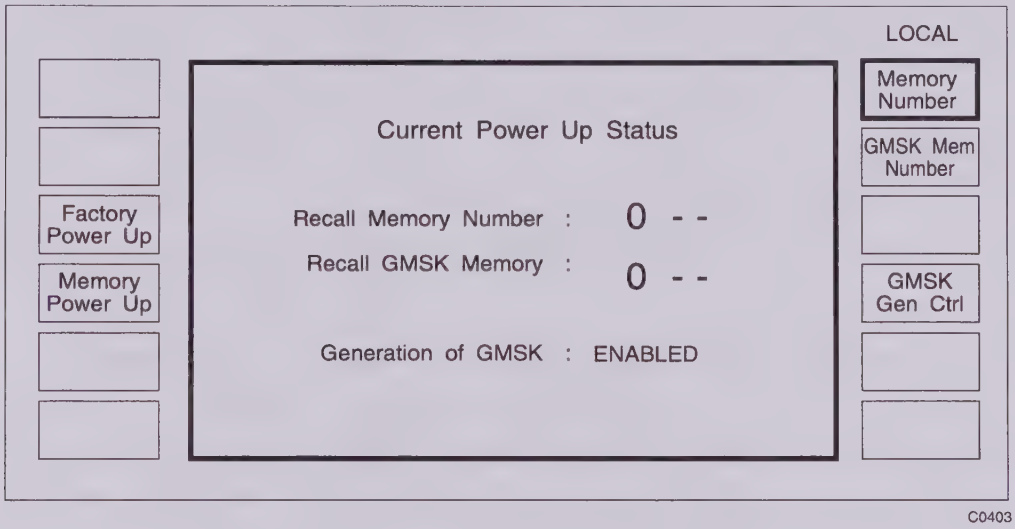


Fig. A-18 Power up options menu with memory power up selected

The default (maximum frequency, minimum level) *Factory Power Up* or a *Memory Power Up* can be selected. If a *Memory Power Up* is selected the signal generator setting is selected by defining the *Memory Number* (which sets carrier frequency, level, modulation mode etc.) and the GMSK memory to be recalled (see page A-13). The *[GMSK Gen Ctrl]* key can be used to set the generator to generate GMSK at power up if it is ENABLED and the modulation mode is GMSK.

ERROR HANDLING

Errors may be divided into three groups - foreground errors generally caused by a user, background errors which represent a condition of the instrument and GPIB errors which occur only when the unit is being controlled by a GPIB controller. Foreground and background errors specific to GMSK operation are shown in Tables A-2 and A-3 respectively.

ERROR MESSAGES

TABLE A-2 FOREGROUND ERRORS

Error		Descriptive text	Error		Descriptive text
No.	Type		No.	Type	
93	exe	DSP Not Responding	151	exe	Illegal Slot Data
94	dde	GMSK Data Checksum	152	exe	Incorrect GMSK Data Type
149	exe	GMSK Parameter Unknown	153	exe	Incorrect Data Length
150	exe	Wrong LF units			

TABLE A-3 BACKGROUND ERRORS

Error		Descriptive text	Error		Descriptive text
No.	Type		No.	Type	
39	dde	GMSK Calibration Checksum	44	dde	No 13 MHz Standard
42	exe	RF Level limited by GMSK	45	exe	Carr., limited by GMSK
43	dde	No external bit clock			

GPIB OPERATION

The following GPIB Mnemonics are used to control the GMSK Bt 0.3 option in addition to those described in Chapter 3-2. But note that the external hysteresis commands HYST and HYST? have no effect.

ADDITIONAL COMMANDS

GMSK [not used alone]

:DSOURCE [not used alone]

:SLOT Select the data source to be internal slot 0-99

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:FRAME Select the data source to be internal slot 0-99

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:MFRAME Select the data source to be internal multiframe 0-99

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:SFRAME Select the data source to be internal superframe 0-39

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:EXTERNAL Select the data source to be external

Data type : None
Allowed suffices : None
Default suffix : None

:CLOCK Select bit clock control for internal data (master/stand alone configurations)

Data type : Character program data (either INTERNAL or EXTERNAL)
Allowed suffices : None
Default suffix : None

:MODOPT [not used alone]

:SBAND Select sideband control

Data type: Character program data (any one of : UPPER, LOWER or AUTO)
Allowed suffices : None
Default suffix : None

:MODPOL Select modulation polarity control

Data type : Character program data (either NORMAL or INVERSE)
Allowed suffices : None
Default suffix : None

:FIDELITY Bt selection control

Data type : Character program data (either NORMAL or CORRUPT)
Allowed suffices : None
Default suffix : None

:ENCODING Select differential data encoding control

Data type : Character program data (either DISABLED or ENABLED)
Allowed suffices : None
Default suffix : None

:ENVELOPE Select envelope control

Data type : Character program data (either CONT or DISCONT)
Allowed suffices : None
Default suffix : None

:CTRL [not used alone]

:TRIGGER Select whether the internal data is generated in single shot or continuous operation

Data type: Character program data (either SNGL or CONT)
Allowed suffices : None
Default suffix : None

:CONFIG Select system configuration

Data type: Character program data (any one of : MASTER, SLAVE or S_ALONE)
Allowed suffices : None
Default suffix : None

:DOPPLER Select doppler control

Data type: Character program data (either DISABLED or ENABLED)
Allowed suffices : None
Default suffix : None

:START Start GMSK internal data generation

Data type: None
Allowed suffices : None
Default suffix : None

:STOP Stop GMSK internal data generation

Data type: None
Allowed suffices : None
Default suffix : None

:TEST [not used alone]

:WFORM GMSK test utility. Select test waveform 0-7 for generation (must set IMODE CAL first)

Data type: Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

:ABORT Exit the test suite

Data type: None
Allowed suffices : None
Default suffix : None

GMSK:DSOURCE? Prepares message containing information on the data source selected

Examples:
```
:GMSK:DSOURCE:EXTERNAL
:GMSK:DSOURCE:FRAME 6
```

GMSK:CLOCK? Prepares message containing information on the bit clock currently in use.

Example:
```
:GMSK:CLOCK INTERNAL
```

GMSK:MODOPT? Prepares message containing information on GMSK modulation control settings in the following format:

:GMSK:MODOPT:SBAND<status>;MODPOL<status>;FIDELITY <status>;ENCODING<status>;ENVELOPE<status>

where: <status> is character program data for the specified mnemonic.

Example:
```
:GMSK:MODOPT:SBAND AUTO;MODPOL INVERSE;FIDELITY
NORMAL;ENCODING DISABLED;ENVELOPE CONT
```

GMSK:CTRL? Prepares message containing information on the GMSK main control settings in the following format:

:GMSK:CTRL:TRIGGER<status>;CONFIG<status>;DOPPLER<status>;

where: <status> is character program data for the specified mnemonic.

Example:
```
:GMSK:MODOPT:SBAND AUTO;MODPOL INVERSE;FIDELITY
NORMAL;ENCODING DISABLED;ENVELOPE CONT
```

SLOT [not used alone]

:LOAD Load slot data into the GMSK editor. All 148 bits must be entered

Data type : String program data consisting of 148 characters from 0 to 1 between string delimiters
Allowed suffices : None
Default suffix : None

:SAVE Save slot data to the requested slot number (1-98)

Data type: Decimal numeric program data
Allowed suffices : None
Default suffix : None

SLOT? Prepares message containing information on the contents of the slot requested in the following format:

:SLOT:LOAD<slot data>;

where: <slot data> is string program data defining the controls of the slot requested.

Data type: Decimal numeric program data
Allowed suffices : None
Default suffix : None

Example:
```
:SLOT:LOAD "100010001000....111110"
```

FRAME [not used alone]

:LOAD Load frame data into the GMSK editor. All 8 slot values must be entered

Data type : Multiple decimal numeric program data
Allowed suffices : None
Default suffix : None

:SAVE Save frame data to the requested frame number (0-99)

Data type: Decimal numeric program data
Allowed suffices : None
Default suffix : None

FRAME? Prepares message containing information on the contents of the frame requested in the following format

:FRAME:LOAD:<frame data>

where: <frame data> is multiple decimal numeric program data defining the contents of the frame requested.

Data type: Decimal numeric program data
Allowed suffices : None
Default suffix : None

Example: `:FRAME:LOAD 34,6,15,99,0,22,44,76`

MFRAME [not used alone]

:LOAD Load multiframe data into the GMSK editor. All 26 frame values must be entered

Data type : Multiple decimal numeric program data
Allowed suffices : None
Default suffix : None

:SAVE Save multiframe data to the requested multiframe value (0-99)

Data type: Decimal numeric program data
Allowed suffices : None
Default suffix : None

MFRAME? Prepares message containing information on the contents of the multiframe requested in the following format

:MFRAME:LOAD:<mframe data>

where: <mframe data> is multiple decimal numeric program data defining the contents of the multiframe requested.

Data type: Decimal numeric program data
Allowed suffices : None
Default suffix : None

Example: `:MFRAME:LOAD 56,78,92,22,....12,0,5`

SFRAME [not used alone]

:LOAD Load superframe data into the GMSK editor. All 51 multiframe values must be entered

Data type : Multiple decimal numeric program data
Allowed suffices : None
Default suffix : None

:SAVE Save superframe data to the requested multiframe value (0-39)

Data type: Multiple decimal numeric program data
Allowed suffices : None
Default suffix : None

SFRAME? Prepares message containing information on the contents of the superframe requested in the following format

:SFRAME:LOAD:<sframe data>

where: <sframe data> is multiple decimal numeric program data defining the contents of the superframe requested.

Data type: Decimal numeric program data
Allowed suffices : None
Default suffix : None

Example: `:SFRAME:LOAD 44,87,29,7,....77,65,1`

MODULATION MODE

MODE Set modulation mode

Data type : Character Program Data (valid combinations of AM, AM1, AM2, FM, FM1, FM2, GMSK, PM, PM1, PM2, WBFM or PULSE, see Table below)

Allowed suffices : None

Default suffix : None

Examples:
```
MODE AM,FM
MODE FM1,FM2
```

Single	Composite	Dual	Dual Composite	GMSK
AM1	AM1,AM2	AM1,FM1	AM1,AM2,FM1,FM2	GMSK
FM1	FM1,FM2	AM1,PM1	AM1,AM2,PM1,PM2	
PM1	PM1,PM2	AM1,WBFM	AM1,AM2,WBFM	
WBFM		PULSE,FM1	PULSE,FM1,FM2	
PULSE		PULSE,PM1	PULSE,PM1,PM2	
		PULSE,WBFM		

Note...

At any time the '1' may be omitted, for example FM is equivalent to FM1. Order is not important, for example AM,FM is equivalent to FM,AM.

MODE? Prepares message containing information on Modulation Mode in the following format:

:MODE:<mode>

where: <mode> is character program data indicating the modulation mode settings.

Example:
```
:MODE FM1,FM2
```

MEMORY - STORE

STO	[not used alone]
:FULL	Full Store 0-49
:PART	Partial Store 0-49
:CFRQ	Carrier Freq Store 0-99
:SEQT	Sequential Tones Store 0-19
:SWEEP	Sweep Store 0-19
:GMSK	GMSK store 0-19

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

Examples:
```
:STO:FULL 17
:STO:CFRQ 83
```

MEMORY - RECALL

RCL	[not used alone]
:FULL	Recall Full 0-49
:FXCF	Recall Full 0-49 (without carrier frequency)
:PART	Recall Partial 0-49
:RXCF	Recall Partial 0-49 (without carrier frequency)
:CFRQ	Recall Carrier Freq 0-99
:SEQT	Recall Sequential Tones Sequence 0-19
:SWEEP	Recall Sweep 0-19
:GMSK	Recall GMSK Store 0-19

Data type : Decimal Numeric Program Data
Allowed suffices : None
Default suffix : None

Examples:
```
:RCL:FULL 15
:RCL:CFRQ 75
```

MEMORY - ERASE

ERASE	[not used alone]
:FULL	Erase all Full Stores
:PART	Erase all Partial Stores
:CFRQ	Erase all Carrier Freq Stores
:SEQT	Erase all Sequential Tones Stores
:SWEEP	Erase all Sweep Stores
:GMSK	Erase all GMSK Stores
:ALL	Erase all Stores

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
:ERASE:FULL 12
:ERASE:ALL
```

MISCELLANEOUS COMMANDS

FSTD Select internal or external frequency standard

Data type : Character program data (any one of INT1, INT5, INT10, EXT1, EXT5 or EXT10, INT13, EXT13 (0ption 005 fitted))
Allowed suffices : None
Default suffix : None

Examples:
```
INT10
EXT5
```

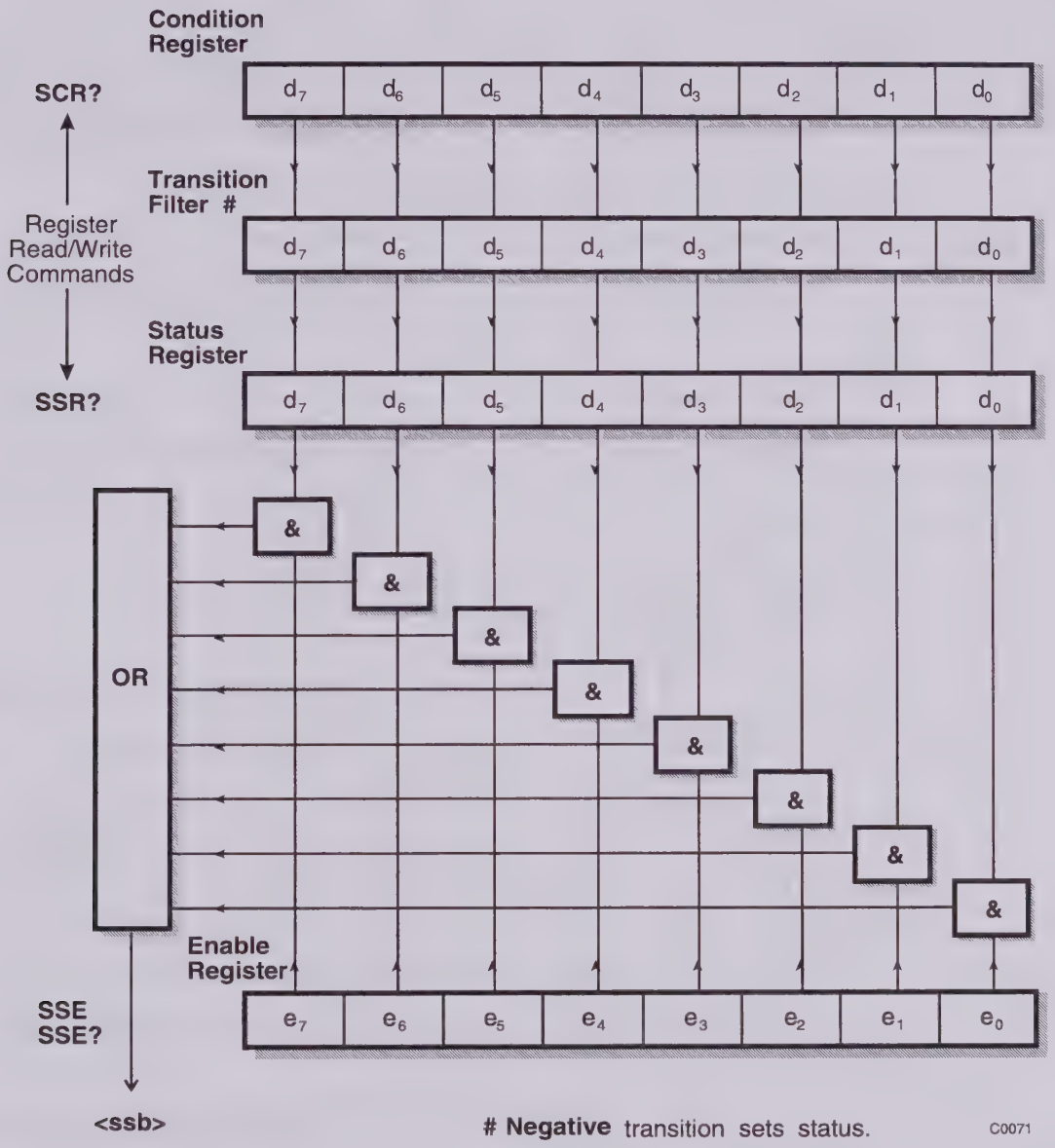
FSTD? Prepares message containing information on frequency standard selection in the format:

:FSTD <char>

Example:
```
:FSTD EXT10
```

INSTRUMENT EVENT REGISTERS

This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.

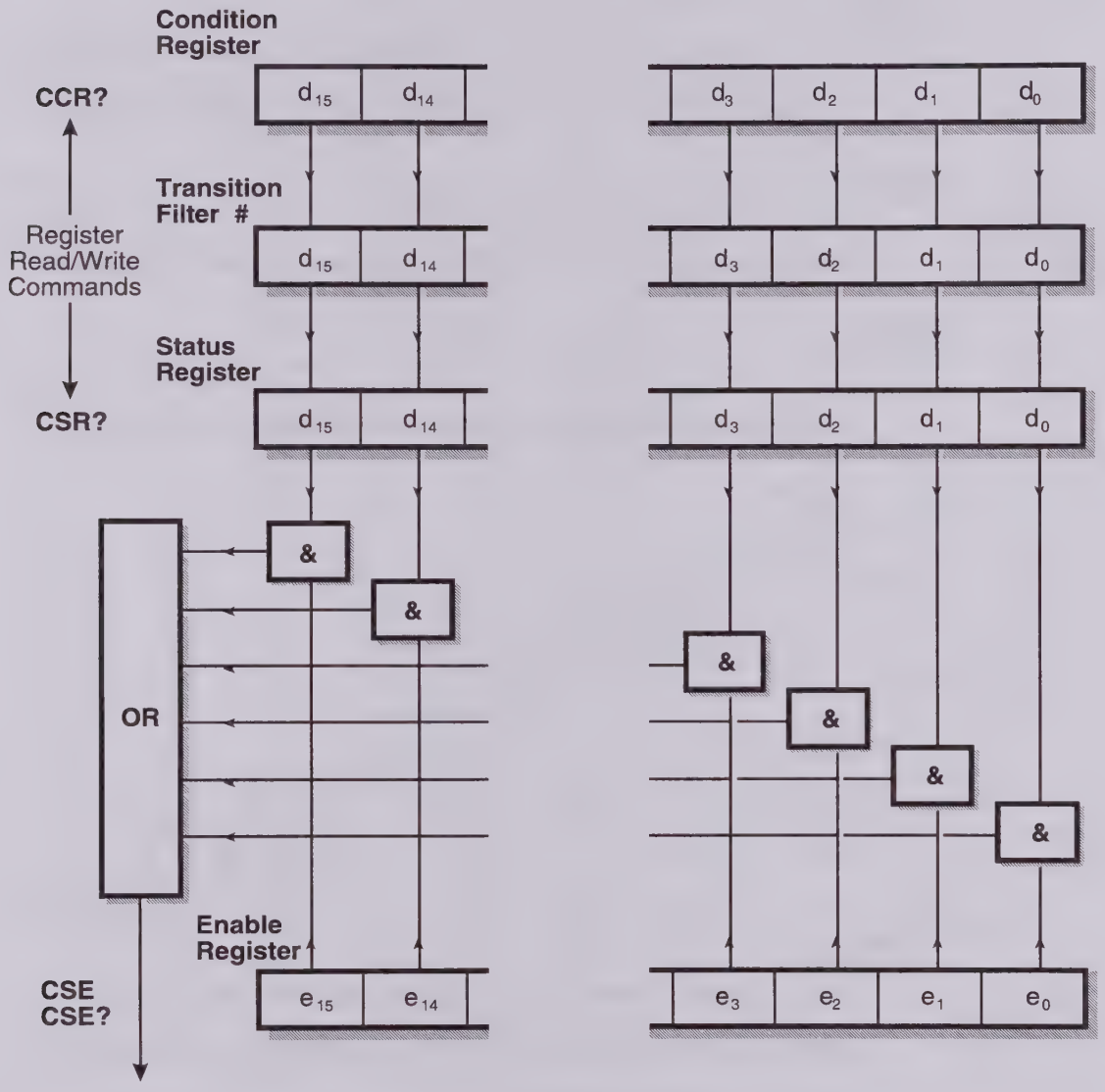


Condition (*SCR?)		Event Status (*SSR?)
d_0	sweep in progress	end of sweep
d_1	sending tones	tones sent
d_2	selfcal in progress	selfcal completed
d_3	dc fm null in progress	dc fm null completed
d_4	generating GMSK	GMSK generation suspended
d_5	not used	not used
d_6	not used	not used
d_7	not used	not used

<ssb> instrument event register summary bit

COUPLING EVENT REGISTERS

This is a device dependant Register and the bits have meanings as shown in the list at the bottom of the page.



d_0	rf level restricted by requested am
d_1	fm restricted by requested carrier frequency
d_2	widebandfm restricted by requested carrier frequency
d_3	am2 depth restricted by requested am1 depth
d_4	fm2 deviation restricted by requested fm1 deviation
d_5	pm2 deviation restricted by requested pm1 deviation
d_6	number of sweep steps restricted by other parameters
d_7	carrier restricted by modulation mode
d_8	rf level restricted by modulation mode
<csb>	coupling event register summary bit

ACCEPTANCE TESTING

INTRODUCTION

The test procedures in this section enable you to verify that the electrical performance of the signal generator complies with the Performance Data given in earlier. The test equipment recommended for this purpose is listed in Table A-4. All tests may be performed with the covers in place and are intended to be carried out in the order given. For convenience, the test equipment and specification for each test are summarized before the test procedure.

TABLE A-4 RECOMMENDED TEST EQUIPMENT

Description	Minimum specification	Example
Spectrum analyzer	10 MHz to 2 GHz Level accuracy ±1 dB	Marconi 2383
DVM	DC accuracy ±0.01 V	Solatron 7150 +
DC power supply	0 V to 5 V	Weir 413D
GMSK analyzer	Measurement of GMSK Bt 0.3 modulation	Arane AR 9000
Signal generator	Frequency range up to 15 MHz. Output level +13 dBm.	Marconi 2030
Counter	Measurement range up to 15 MHz	Marconi 2435

GMSK Bt 0.3 MODULATION FIDELITY

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
GMSK analyzer	Measurement of GMSK Bt 0.3 modulation	Arane AR 9000

(1) Connect the UUT to the GMSK analyzer.

(2) Use the GMSK analyzer to ensure that the UUT is within its specification.

RF LEVEL ACCURACY

SPECIFICATION
RF level accuracy ±2 dB

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer	10 MHz to 2 GHz Level accuracy ±1.5 dB	Marconi 2383

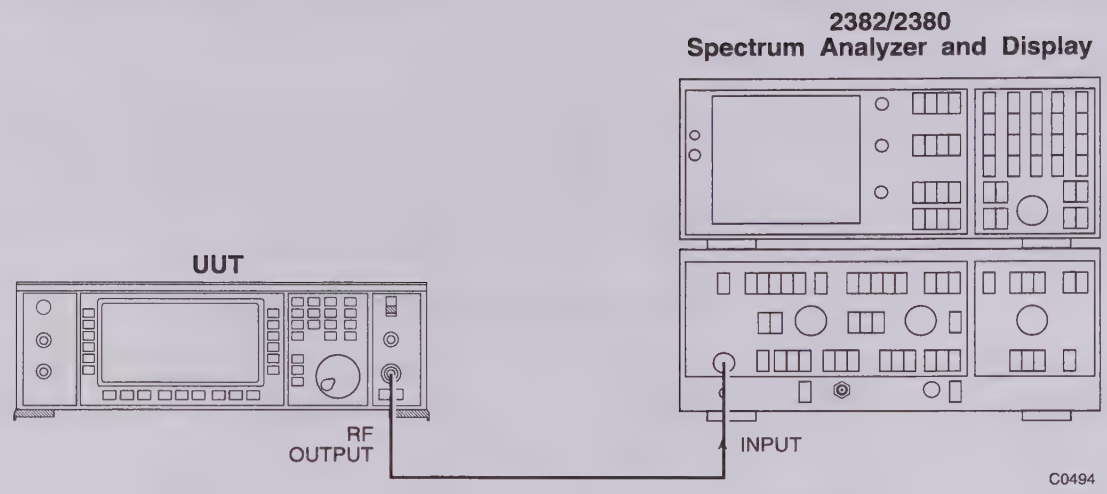


Fig. A-19 RF level test set-up

(1) Connect the test equipment as shown in Fig. A-19.

(2) Obtain a set of calibrated levels for the spectrum analyzer using the following procedure:-

Preset and calibrate	
Reference level	0 dBm
Span/div	50 kHz
Single sweep	

Set the UUT as follows:-

[Carrier Freq]	as detailed in Table A-5
[RF Level]	-10 dBm
[MOD]	off

Tune the spectrum analyzer to the same frequency as the UUT. Take a sweep on the spectrum analyzer and use the marker peak find to measure the signal amplitude. Note this as the **calibrated level.** Repeat for all the frequencies in Table A-5.

(3) Set the UUT to:-

[Carrier Freq]	10 MHz
[RF Level]	-10.0 dBm
[UTIL] *[Mod'n Mode]* [GMSK]	

[UTIL] *[Menu 2] [Latch Data] [Latch Number]* 103 [enter] *[Latch Data]* 152 [enter]

This selects test waveform 0 which is a single tone at the selected frequency and level.

(4) Check that the output level error with respect to the calibrated level is within specification.

(5) Repeat (3) and (4) above for the frequencies shown in Table A-5.

TABLE A-5 RF LEVEL TEST FREQUENCIES

Reference Frequency	Measured cal level	Measured level	Calculated error
10.00			
56.25			
131.25			
206.25			
356.25			
431.25			
506.25			
581.25			
656.25			
731.25			
806.25			
881.25			
956.25			
1031.25			
1106.25			
1181.25			
1256.25			
1331.25			
2031 Only			
1406.25			
1481.25			
1556.25			
1631.25			
1706.25			
1781.25			
1856.25			
1931.25			
2000.00			

PHASE ACCURACY

SPECIFICATION
Phase accuracy as defined by GSM 05.05 - 4.6 is 1 degree RMS, 3 degrees peak.
Note... An indirect method of measuring the phase accuracy is used. This uses built-in test waveforms which when analyzed give an indication to the size of the phase error introduced by the modulation process.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer	10 MHz to 2 GHz Level accuracy ±2 dB	Marconi 2383

(1) Connect the test equipment as shown in Fig. A-19.

(2) Set the UUT as follows :-

[Carrier Freq]	100 MHz
[RF Level]	-20 dBm
[UTIL]*[Mod Mode] [GMSK]*	
[MOD]	On

(3) On the UUT built-in test waveform 1 can be selected by either :-

[UTIL] *[Menu 2] [Latch Data] [Latch Number]* 103 [enter] *[Latch Data]* 153 [enter]

or:

Unlock the UUT to Level 2. Then select :-

[UTIL] *[Cal Vals][GMSK] [Test W'forms] [Waveform Number]* 1 [enter]

Test waveform 1 is a carrier modulated with 15 tones each spaced about 102 kHz apart.

(4) Set the spectrum analyzer up as follows :-

Preset and calibrate	
Reference frequency	100 MHz
Span/div	200 kHz
Reference level	- 20 dB
Single sweep.	

Take a sweep on the spectrum analyzer. The display should be similar to Fig. A-20.

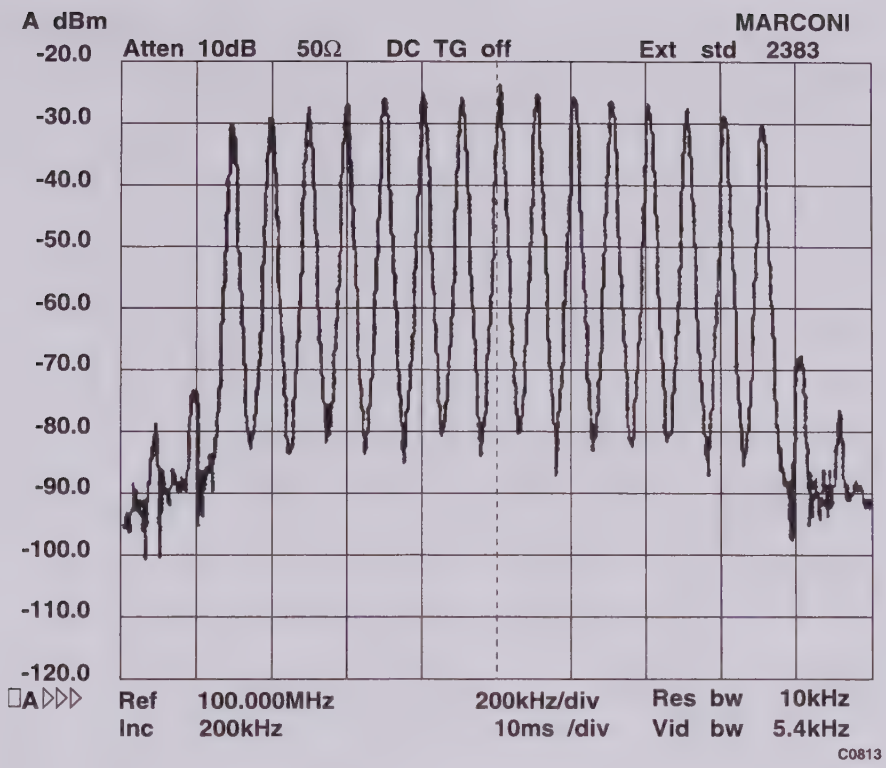


Fig. A-20 Spectrum of built-in test waveform 1

On the trace check that :-

(a) All 15 of the test tones are visible.

(b) There are no noticeable spurious signals.

(c) The shape of the complete spectrum is symmetrical.

(5) Using the marker note the position and location of the third, sixth, tenth and thirteenth tones (counting from the left). See Table A-6.

(6) Select waveform 2 as follows :-

[UTIL] *[Menu 2] [Latch Data] [Latch Number]* 103 [enter]*[lLatch Data]* 154 [enter]

or :-

Unlock the UUT to Level 2. Then select :-

[UTIL] *[Cal Vals] [GMSK] [Test W'forms] [Waveform Number]* 2 [enter]

Test waveform 2 is similar to test waveform 1, but 4 of the tones have been suppressed. The suppressed tones are the third, sixth, tenth and thirteenth tones (counting from the left).

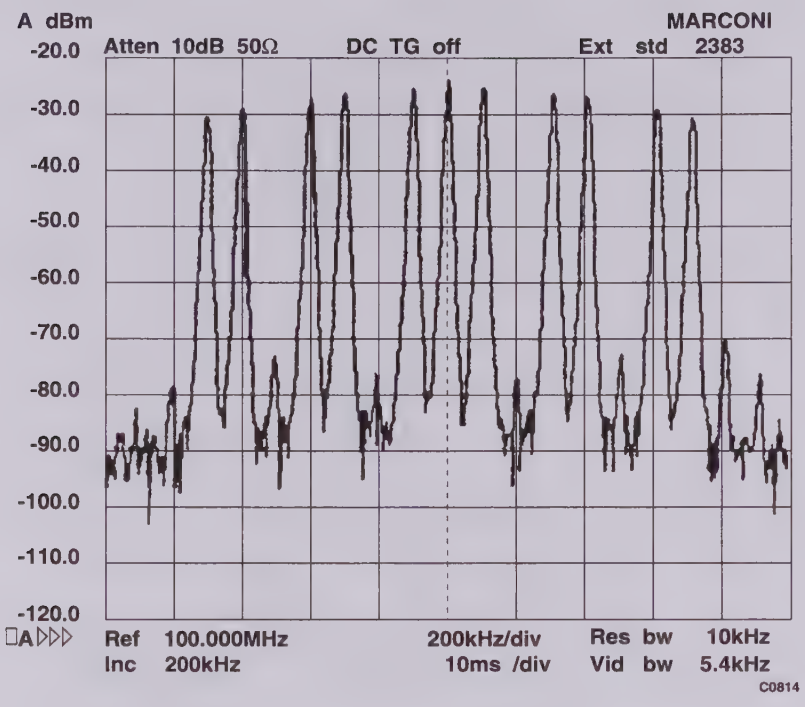


Fig. A-21 Spectrum of built-in test waveform 2

(7) On the spectrum analyzer take a sweep. The displayed spectrum should be similar to the spectrum shown in Fig. A-21.

(8) Tune the spectrum analyzer to the frequency of the 3rd tone and set :-

Span/div	1 kHz
Video average	8 sweeps
Marker peak find	

The marker gives the level of the suppressed tone. Ensure that the measured level is at least -40 dBc with respect to the original level.

(9) Repeat (8) for the sixth, tenth and thirteenth tones.

TABLE A-6 SUPPRESSED LEVELS FOR WAVEFORM 2

Tone	Frequency	Ref level	Suppressed level
3rd	_____	_____	_____
6th	_____	_____	_____
10th	_____	_____	_____
13th	_____	_____	_____

Note...

The level of the suppressed tone is proportional to the amount of distortion which is introduced during the analogue signal processing. A measured level of -40 dBc would represent a worst case phase error of 0.15 degrees RMS.

OFF SLOT SUPPRESSION

SPECIFICATION
Better than - 70 dBc at 0 V

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer	10 MHZ to 2 GHz Level accuracy ±2 dB	Marconi 2383
DVM	DC accuracy ±0.01 V	Solatron 7150 +
DC power supply	Range 0 V to 5 V	Weir 413D

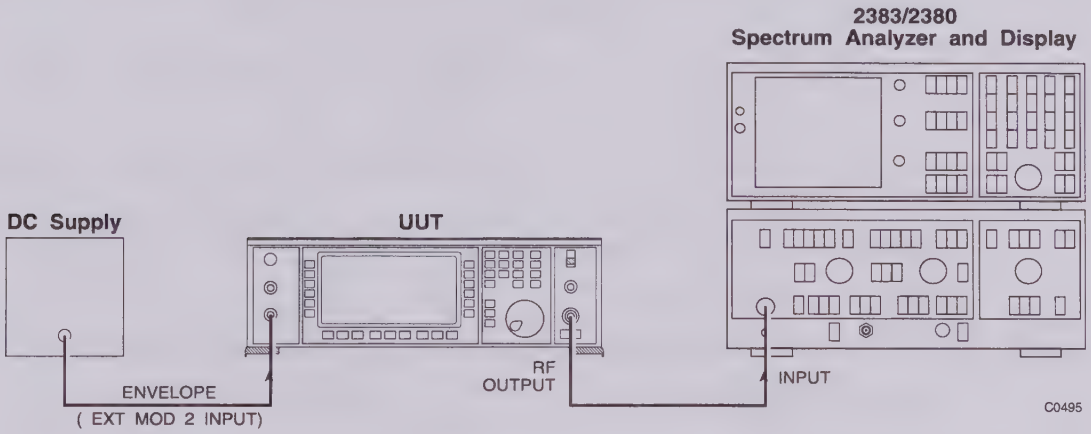


Fig. A-22 Off slot suppression test set-up

(1) Set the UUT as follows :-

[Carrier Freq] 100 MHz
[RF Level] 0 dBm
[UTIL] *[Mod'n Mode] [GMSK]*
[SIG GEN]

[GMSK Control] [Int/Ext Data] select ext data

Ignore the internal standard error which is displayed.

[GMSK Control] [Config Select]

Ensure that the control page is set up as follows :-

Trigger Control	*Continuous*
Configure Control	*Stand Alone*
Doppler	*Disabled*
Sideband	*Upper*
Mod polarity	*Normal*
GMSK Fidelity	*Normal*
Diff Encoding	*Enabled*
Envelope Control	*Discontinuous*

(2) Connect the DC source to the DVM and adjust the voltage until the DVM reads 1 ±0.02 V. (Note that the carrier frequency is shifted by +67.7 kHz from 100 MHz.)

(3) Connect the DC source to the ENVELOPE socket (EXT MOD 2 INPUT) as shown in Fig. A-22.

(4) Set the spectrum analyzer as follows:-

Ref frequency	100 MHz
RF level	0 dBm
Span/div	200 kHz
Sweep time/div	200 ms
Sweep mode	single sweep

Take a sweep on the spectrum analyzer and use the marker to measure the peak amplitude. Note this as a reference level.

(5) Set the DC power supply to 0 V.

(6) Take a sweep on the spectrum analyzer. Use the marker to measure peak level.

Ensure that the measured level is -70 dBc with respect to the reference level.

FREQUENCY STANDARD

SPECIFICATION
In GMSK mode an input or output at 13 MHz is available.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Signal generator	Freq range up to 15 MHz. Output level +13 dBm	Marconi 2030
Counter	Frequency range up to 15 MHz	Marconi 2435

Output frequency check

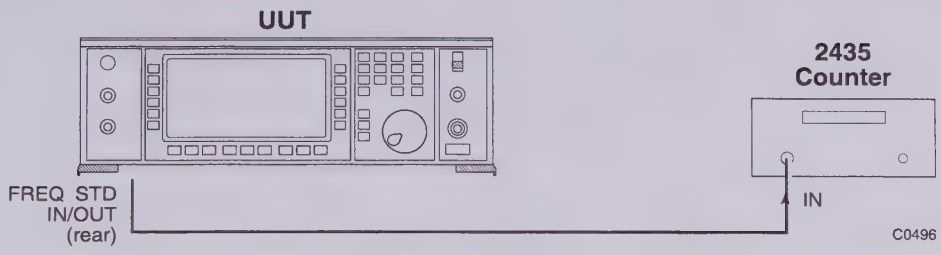


Fig. A-23 Frequency standard output test set-up

(1) Connect the test equipment as shown in Fig. A-23.

(2) Set the UUT as follows :-

[UTIL] *[Mod'n Mode] [GMSK]*
[UTIL] *[Freq Std] [Int 13 MHz]*

(3) Ensure that the frequency measured on the counter is 13 MHz ±3 Hz.

Frequency standard locking test

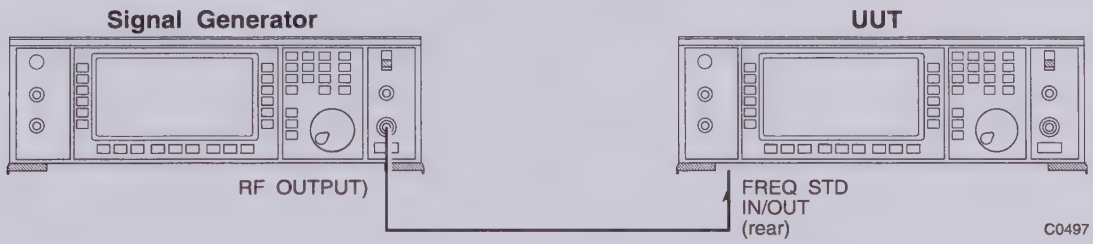


Fig. A-24 Frequency standard locking test set-up.

(1) Set the UUT as follows :-

[UTIL] *[Mod'n Mode] [GMSK]*
[UTIL] *[Freq Std] [Ext 13 MHz]*

(2) Ensure that UUT displays No 13 MHz Standard or VCXO Out of Lock.

(3) Connect the test equipment as shown in Fig. A-24.

(4) Set the signal generator as follows :-

Carrier freq	13 MHz
RF level	13 dBm

(5) Ensure that the external standard error is removed.

Annex B
OPTION 006 AVIONICS

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GENERAL DESCRIPTION

This option provides internal generation of waveforms suitable for testing Instrument Landing Systems (ILS) and VHF Omnidirectional Radio Range (VOR) systems. Option 006 requires Option 001 (Second Modulation Oscillator) to be fitted.

ILS mode

In ILS mode the SDM (Sum of Depth of Modulation) of the 90 Hz and 150 Hz tones is entered to a resolution of 0.1% AM depth. The DDM (Difference in Depth of Modulation) is entered to a resolution of 0.01% depth for a DDM up to 20% and 0.1% for higher DDM settings. A choice of which tone is dominant is available to the user. DDM is also displayed in μA, to a resolution of 0.01 μA.

The 30 Hz repetition frequency of the ILS waveform can be adjusted in 0.1 Hz steps. For 0% DDM additional modulation signals can be added to the ILS waveform.

Marker beacon mode

In marker beacon mode the outer, middle and inner beacons can be tested by simple key selection.

VOR mode

In VOR mode the AM depth of the sub-carrier and 30 Hz tone can be independently set and the relative phase of the 30 Hz tone and the modulation tone on the sub-carrier is set by directly entering the bearing information in degrees. The VOR rate repetition rate of 30 Hz can be adjusted in 0.1 Hz steps. For a fixed bearing additional modulation can be applied to simulate voice/identity signal. A *[To/From]* beacon key provides a rapid means of reversing a bearing entry and accounting for different bearing conventions.

ADF mode

The ADF mode provides a simple method of testing automatic direction finding receivers operating on carriers with amplitude modulation.

SEL-CAL mode

In SEL-CAL mode the signal generator enables selective calling tones to be generated as amplitude modulation. This facility can be used to test the aircraft operator's communication system on commercial aircraft.

PERFORMANCE DATA

The following specification is in addition to that included in the 2030 series specification.

ILS MODE

Sum of Depth of Modulation (SDM)

Range:	0 to 99.9% in 0.1% steps representing the arithmetic sum of the individual tone depths.
Selection:	By keyboard entry of data and variation by ⇑/⇓ keys and rotary control.
Accuracy of SDM:	±2% of setting for carrier frequencies up to 400 MHz.

Difference in Depth of Modulation (DDM)

DDM can be entered in % or as a modulation index.

Range:	0 to 20% in 0.01% steps. 20 to 99.9% in 0.1% steps, limited by SDM.
Selection:	By keyboard entry of data and variation by ⇑/⇓ keys and rotary control.
Accuracy of DDM:	±0.0003 DDM ±0.02 of setting. At 0 DDM (on course) accuracy is ±0.0003 DDM (0.03% depth); At 0.155 DDM accuracy is ±0.0034 DDM (0.34% depth).
Tone frequencies:	90 Hz, 150 Hz nominal. Tone frequency may be adjusted by varying the ILS repetition rate of 30 Hz in 0.1 Hz steps. Tone frequencies maintain 3:1 and 5:1 relationships with the ILS rate.
Tone suppression:	Either tone can be suppressed.

Additional modulation:

Available for 0% DDM from an internal or external modulation source.

Frequency accuracy:	As frequency standard.

Audio output:

Available from the LF OUTPUT connector.

Accuracy of DDM:	±0.03% ±0.005 of setting. At 0 DDM (on course), accuracy is ±0.0003 DDM.

MARKER BEACON MODE

Provides default modulation of 95% AM depth on a 75 MHz carrier at the modulation rate of 400 Hz (outer beacon), 1.3 kHz (middle beacon) or 3 kHz (inner beacon). AM depth, carrier frequency and modulation frequency can be changed from the default values.

VOR MODE

9.96 kHz sub-carrier

Range:	0 to 49.9% depth in 0.1% steps.
Modulation:	Frequency modulated by a 30 Hz tone with 480 Hz deviation.

30 Hz tone

Range:	0 to 49.9% depth in 0.1% steps. Arithmetic sum of 30 Hz tone and sub-carrier AM depth are limited to 99.8%.
Selection:	By keyboard entry of depth and variable by ⇑/⇓ keys and rotary control.
Bearing control:	Relative phase of 30 Hz tone and sub-carrier modulation adjustable from 0° to 359.9° in 0.1° steps by entering VOR bearing. Bearing can be entered as TO or FROM the beacon.
Bearing accuracy	±0.05°.

Additional modulation: Available on 0° bearing from an internal or external modulation source.

AM depth accuracy: ±3% of setting ±0.5% for carrier frequencies up to 400 MHz.

Frequency: The VOR repetition frequency of 30 Hz may be varied in 0.1 Hz steps. The sub-carrier frequency and deviation maintain a fixed relationship with the VOR repetition rate

Frequency accuracy: As frequency standard.

Audio output: Available from the LF OUTPUT socket.

ADF MODE:

Provides default modulation of 30% AM depth on a 190 kHz carrier at 1 kHz modulation rate. AM depth, carrier frequency and modulation frequency can be changed from the default values.

SEL-CAL MODE

Provides amplitude modulation with SEL-CAL (SELective CALling) tones.

Data entry	By soft keys labelled A to S, of up to 2 pairs of characters.
Timing:	Default 1 s tone duration, 250 ms tone gap. Tone gap, duration and start delay can be changed from the default values.

AVIONICS OPERATION

This section explains how to use Option 006 when fitted to a 2030 series Signal Generator. Familiarity with the normal operation of the instrument is assumed.

The Avionics option offers modes of operation suitable for testing ILS and VOR systems. It also provides efficient testing of ADF (Automatic Direction Finders) and SEL-CAL receivers. It is assumed that the operator has some knowledge of the operation of these avionics systems.

The Avionics mode is selected by pressing the [UTIL] key and selecting the *[Mod'n Mode]* key on the Utilities 1 page shown in Fig. B-1 to obtain the menu shown in Fig. B-2. Selecting *[Avionics Mode]* from this menu will result in the Avionics mode menu shown in Fig. B-3 being displayed. Pressing the appropriate soft key will result in the instrument entering the required mode of operation; pressing *[Other Modes]* returns the display to the Modulation mode selection menu.

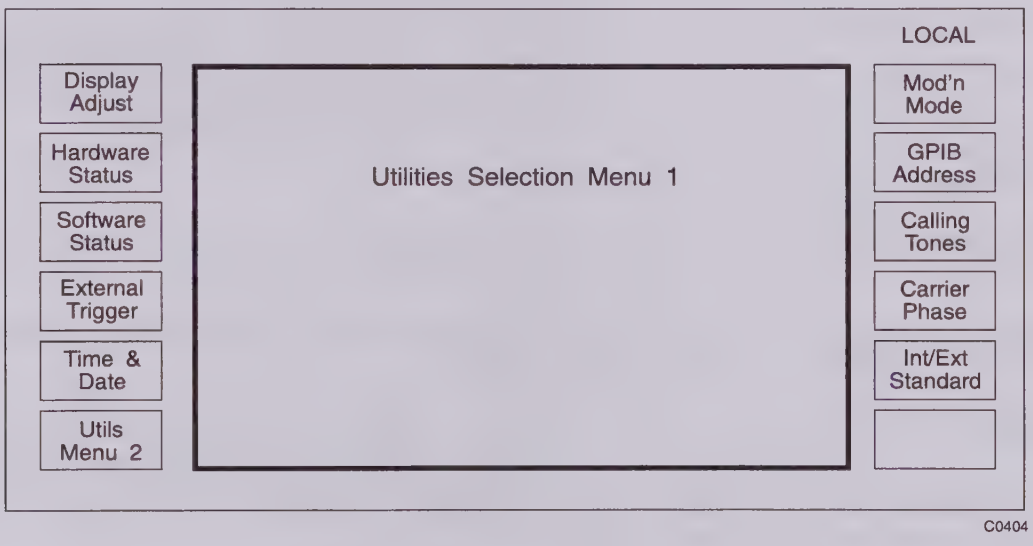

Fig. B-1 Utilities selection menu 1

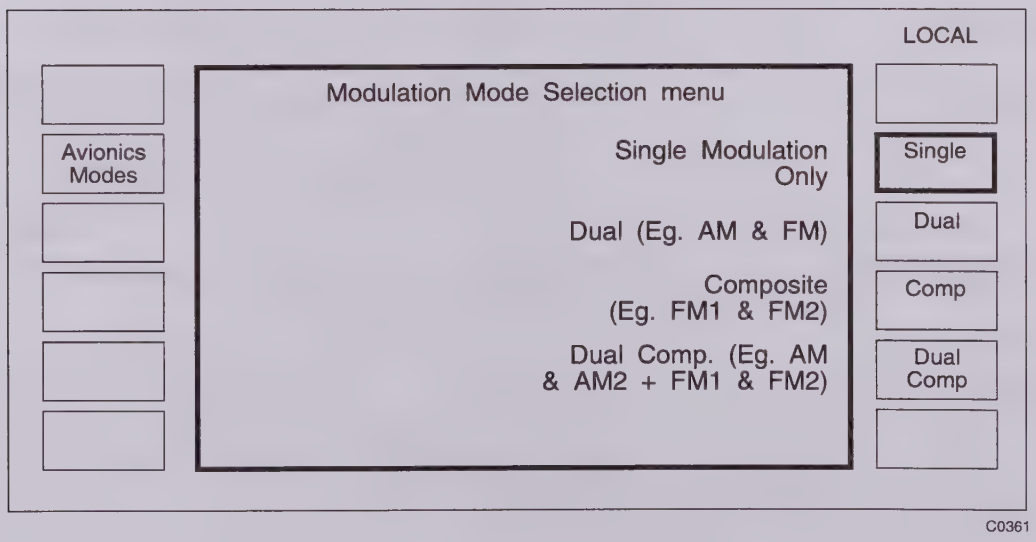

Fig. B-2 Modulation mode selection menu

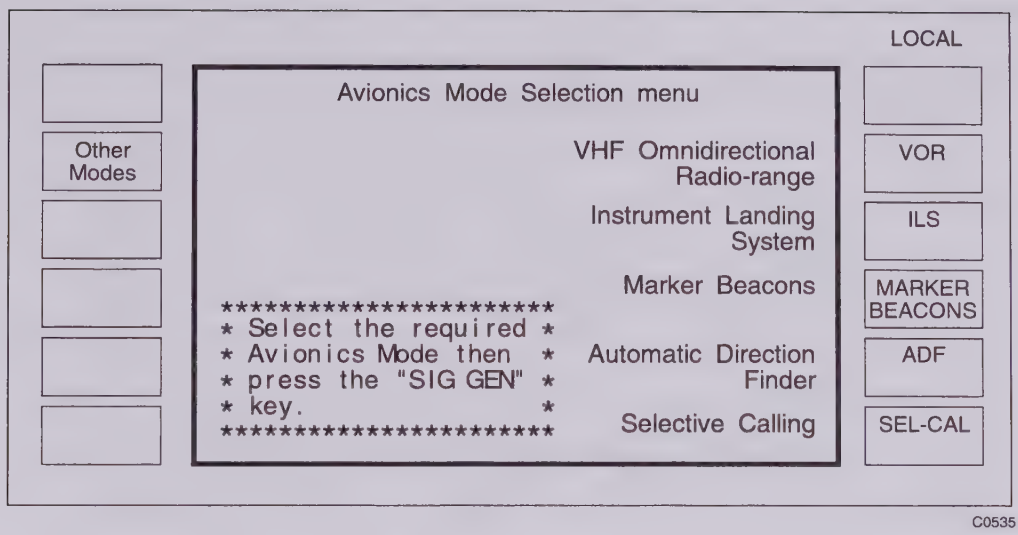

Fig. B-3 Avionics mode selection menu

ILS mode

Pressing [ILS Mode] and then pressing the [SIG GEN] key will result in the display shown in Fig. B-4. The default carrier frequency for ILS mode is 108.1 MHz.

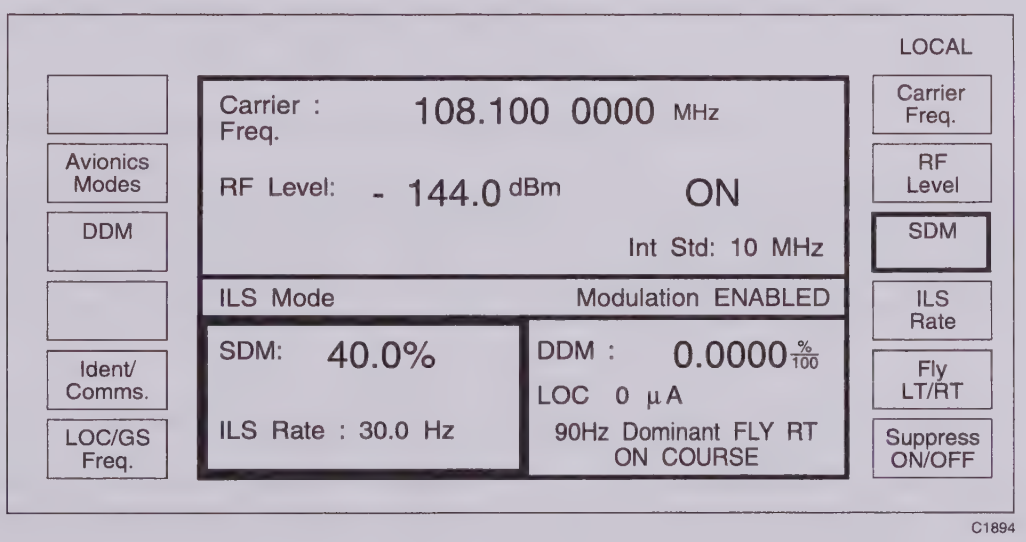

Fig. B-4 SDM selection menu

The sum of depth of modulation (SDM) is the arithmetic sum of depth of the modulating 90 Hz and 150 Hz tones. Using the *[SDM]* key the depth can be entered in %. The ILS rate is normally set to 30 Hz and is the ILS waveform repetition rate. Its frequency can be modified using the *[ILS Rate]* key. If the ILS rate is adjusted the frequency of the 90 Hz and 150 Hz alter on a pro-rata basis (e.g. If ILS Rate = 29 Hz the tone frequencies are 87 Hz and 145 Hz).

DDM control

From the SDM Selection Menu (Fig. B-4) DDM may be entered by pressing the *[DDM]* key to obtain the display shown in Fig. B-5.

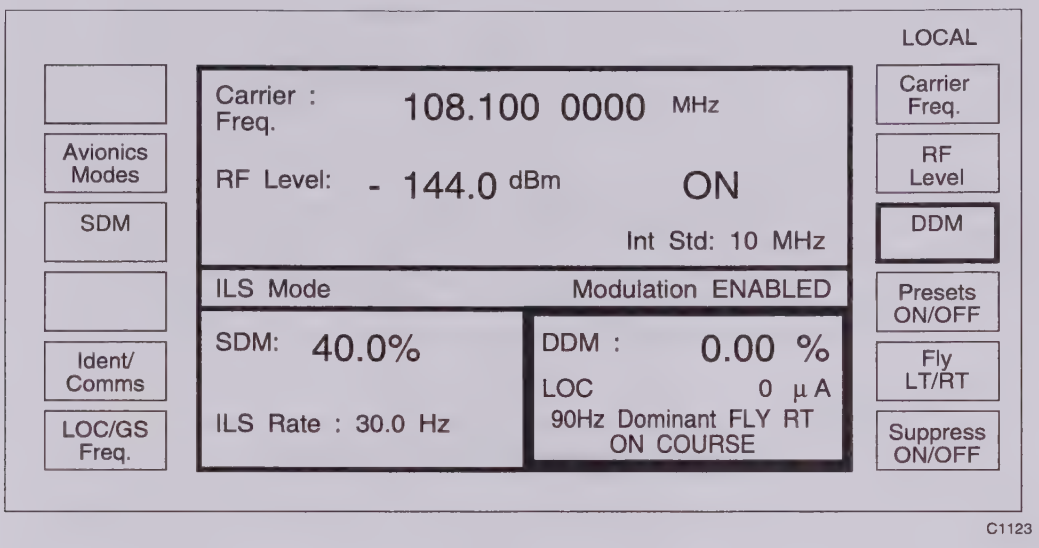

Fig. B-5 DDM selection menu

The DDM can be entered in %, as a modulation index (%/100) or in microamps (µA) and displayed on the *Sig Gen* menu in %, as a modulation index, microamps or as the attenuation ratio between the 90 Hz and 150 Hz tones in dB, according to the formula:

$$R_{dB} = 20 \log_{10} \left\{ \frac{(SDM + DDM)}{(SDM - DDM)} \right\} \mu A$$

If the setting to be entered is a modulation index terminate the entry with the [enter] key. Alternatively, if the setting to be entered is in microamps terminate the entry with the [ms] key. The microamp entry is converted to the nearest 0.01%. If the carrier frequency is below 200 MHz the signal is assumed to be for a localiser and if it is above 200 MHz the signal is assumed to be for a glideslope. The following conversion factors are used:

150 µA ≡ 15.5% DDM on the localiser

150 µA ≡ 17.5% DDM on the glideslope

The units displayed can be changed without entering any data. Press the [enter] and [%] keys to toggle between modulation index and percentage. Press the [ms] and [dB] keys to toggle between microamps and attenuation ratio.

The *[Fly/LT/RT]* key can be used to set which tone has the greater depth of modulation and the dominant tone is displayed under the DDM set. When 90 Hz is dominant the aircraft is either to the left (localiser) or too high (glideslope). The corresponding action to be taken is displayed as *FLY RT* and *FLY DN*. Similarly when 150 Hz is dominant the aircraft is either to the right (localiser) or too low (glideslope). The corresponding action to be taken is displayed as *FL LT* and *FLY UP*. If 0% DDM is set the additional text *ON COURSE* is displayed.

DDM values can be entered using the DDM presets which provide a fast method of selecting commonly used DDM values. The DDM presets are selected using the *[Presets ON/OFF]* key and Fig. B-6 is produced.

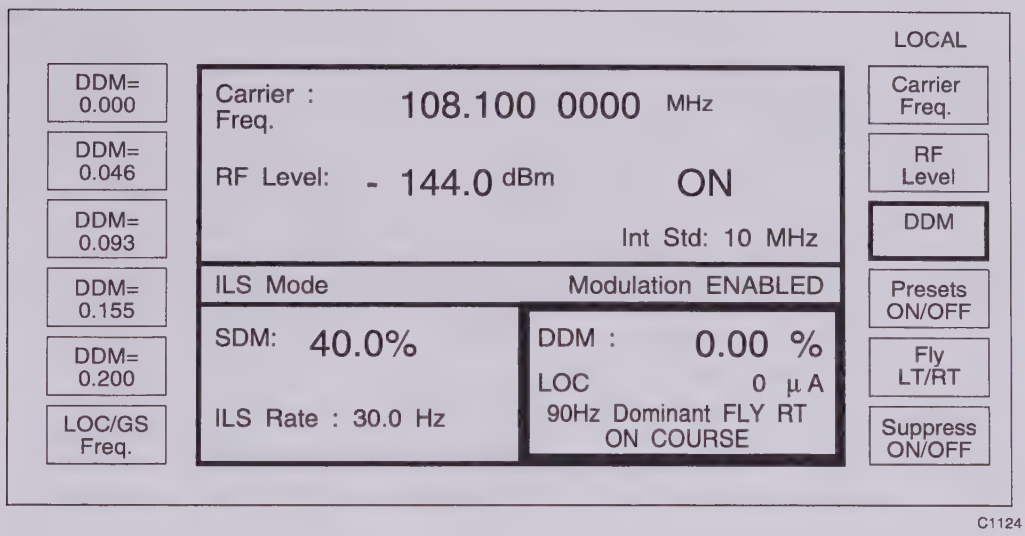

Fig. B-6 DDM selection menu with presets

Five DDM preset values can be selected for either localizer or glideslope frequencies. The DDM value can still be modified by the normal numeric entry, increment or rotary controls as well as the preset mechanism. The DDM value is displayed in modulation index format when a preset value is chosen. The equivalent glideslope DDM preset keys (0.000, 0.045, 0.092, 0.175, 0.400) are displayed when a glideslope frequency is entered. The normal DDM selection menu is selected by pressing the *[Presets ON/OFF]* key.

Localiser/glideslope frequency conversion

International agreements specify that localiser and glideslope frequencies are paired on any ILS installation. The *[LOC/GS Freq.]* provides a convenient means of switching between the localiser and glideslope frequencies. Provided the carrier frequency is set near to a recognised ILS frequency, pressing *[LOC/GS Freq.]* will result in the carrier being changed to appropriate paired frequencies.

Note...

If the carrier frequency is not set precisely to the glideslope or localiser channel frequency and the *[LOC/GS Freq.]* is operated twice, the frequency will be reset to the nominal localiser/glideslope frequency.

The default SDM is 40% for localiser and 80% for glideslope, and pressing *[LOC/GS Freq.]* will automatically reset the SDM to the default value.

When changing from localiser to glideslope the *[Ident/Comms]* key will disappear and then reappear when changing back to localiser.

Tone suppression

The 90 Hz or 150 Hz tone can be suppressed when either the SDM or DDM display box is selected for data entry, using the *[Suppress ON/OFF]* key. This will result in the non-dominant tone being suppressed without altering the SDM or DDM (% or index) as shown in Fig. B-7. Selecting *[Suppress 90/150]* will change the tone to be suppressed. The modulation depth value of the active tone is displayed under the SDM setting.

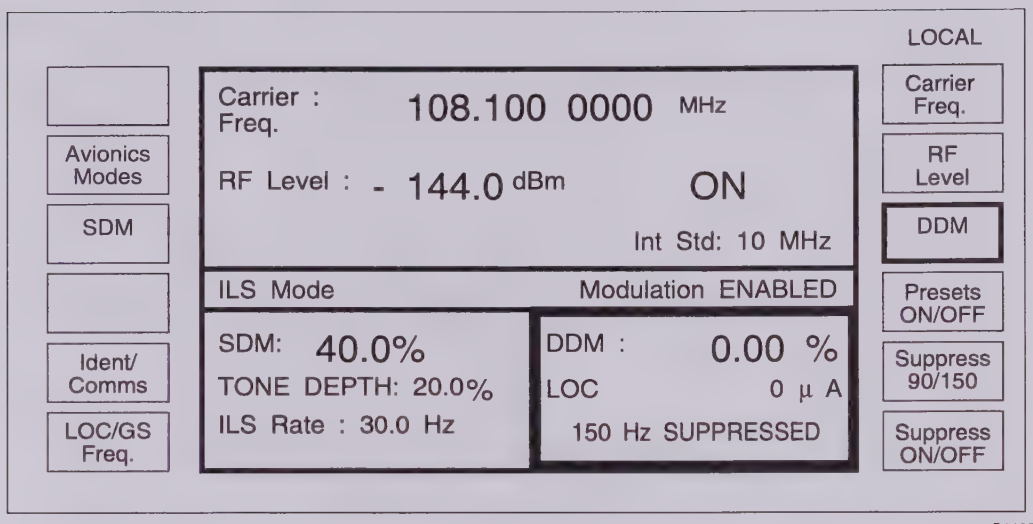

Fig. B-7 Tone suppression menu

Communication channel testing

ILS systems allow the provision of an emergency voice channel on localiser frequencies. This channel can be tested by selecting the *[Ident/Comms]* key to produce a display similar to the one shown in Fig. B-8.

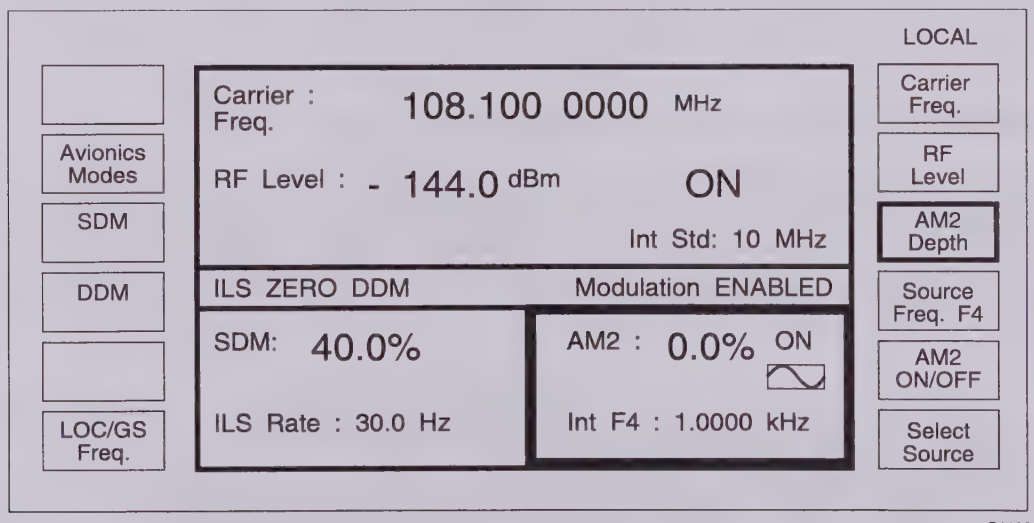

Fig. B-8 Ident/Comms selected

In this mode a fixed 0% DDM signal is provided and an additional modulation signal can be added using the *[AM2 Depth]* key. The source of this additional modulation can be set using the *[Select Source]* key. If internal modulation is selected the source frequency can be modified using the *[Source Freq.]* key. Selecting *[SDM]* or *[DDM]* will return the instrument to normal ILS mode.

Communication channel testing is normally only required on localiser frequencies and consequently changing from localiser to glideslope using the *[LOC/GS Freq.]* key will result in the *[Ident/Comms]* key disappearing. Additional modulation can be obtained on a glideslope frequency by directly entering the glideslope frequency instead using the numeric keys.

Marker beacon mode

The marker beacon mode is selected using the *[MARKER BEACONS]* key on the Avionics Mode Selection Menu shown in Fig. B-3. Selecting maker beacon mode and pressing the [SIG GEN] key produces the display shown in Fig. B-9. Initially the outer beacon is selected by default. The *[Middle Beacon]* and *[Inner Beacon]* keys change the modulation frequency to 1.3 kHz and 3 kHz respectively. Carrier frequency and AM depth can be altered, but always default to 75 MHz and 95% respectively. Modulation frequency can be changed using the *[Source Freq: F1]* key. Modulation source can be changed using the *[Select Source]* key. Pressing the *[Avionics Modes]* key returns the display to the Avionics Mode Selection Menu.

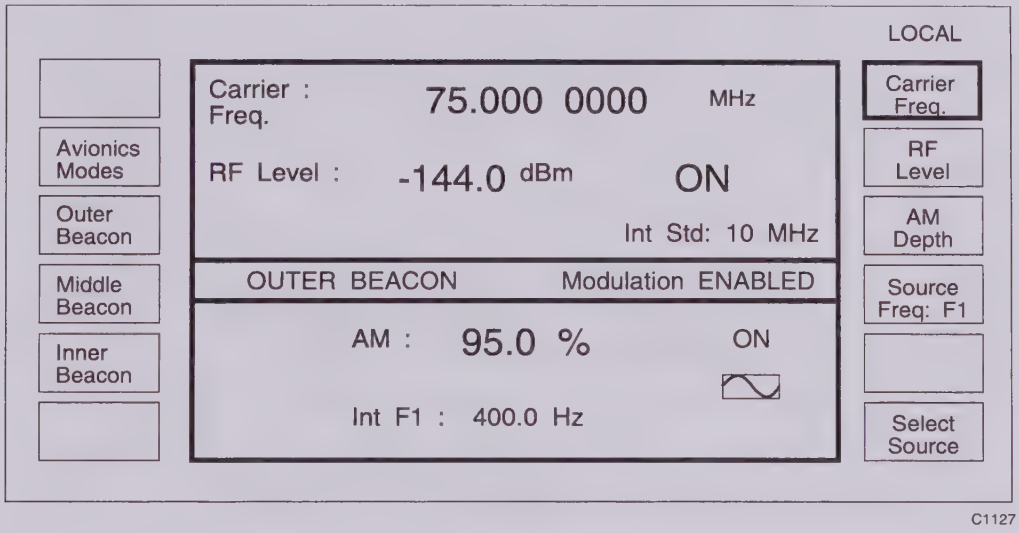

Fig. B-9 Marker beacon mode selection menu

VOR mode

VOR operation can be obtained from the Avionics Mode Selection Menu (Fig. B-3) or if other avionics modes have been selected, by first pressing the *[Avionics Modes]* key. Selecting *[VOR Mode]* will produce the display shown in Fig. B-10. The default carrier frequency for the VOR mode is 108 MHz.

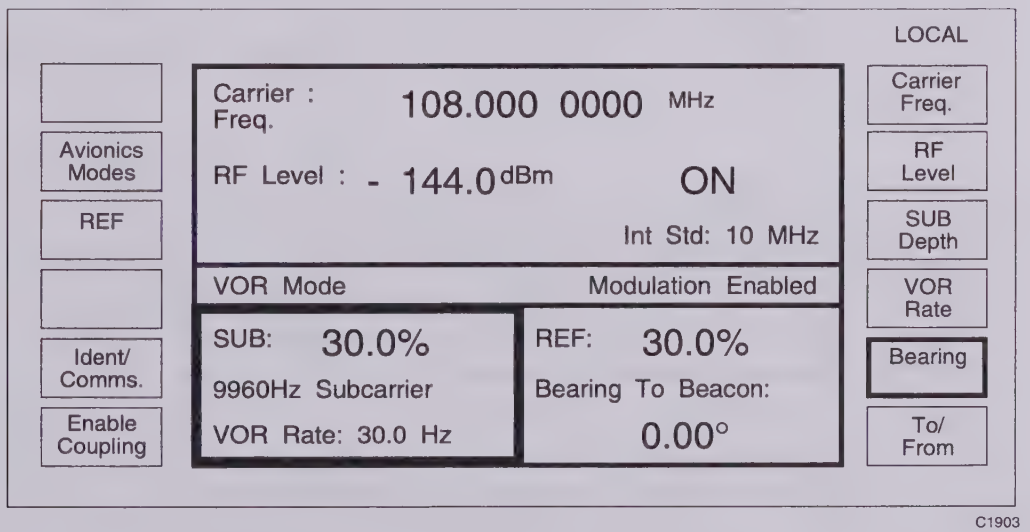

Fig. B-10 VOR mode operation

Using the *[SUB Depth]* key the AM depth of the 9960 Hz sub-carrier can be entered in % and the *[VOR Rate]* key can be used to vary the VOR repetition rate from its normal setting of 30 Hz.

To vary the 30 Hz tone AM depth or the VOR bearing select the *[REF]* key to produce the display shown in Fig. B-11. The 30 Hz tone AM depth can be entered using the *[REF Depth]* key and bearing information can be entered in degrees using the *[Bearing]* key followed by the bearing data and the [enter] key. Conventions for bearing are not internationally consistent so a *[To/From]* key is provided to allow toggling between these two conventions. Operating this key does change the bearing but not the value displayed. It also provides a convenient way of providing a 180° bearing reversal.

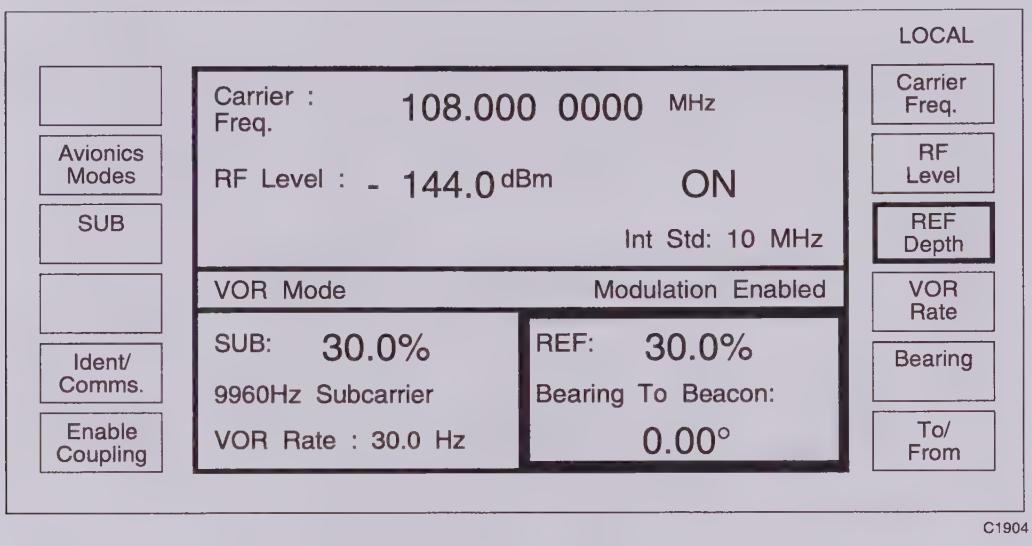

Fig. B-11 REF selected

The AM depth of the 9960 Hz sub-carrier and the 30 Hz tone can be varied simultaneously by pressing the *[Enable Coupling]* key which produces the display shown in Fig. B-12.

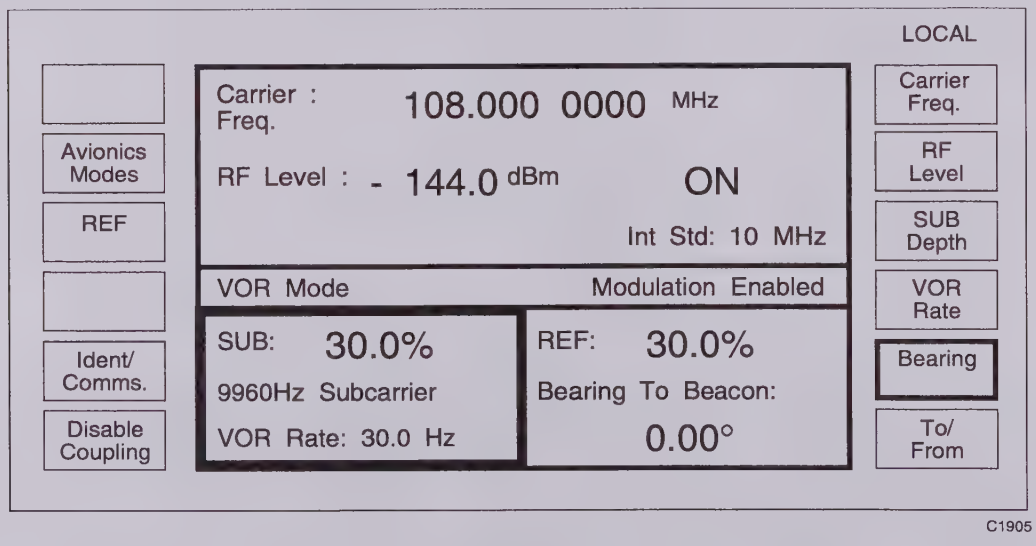

Fig. B-12 VOR made operation with "Coupling" enabled

When "coupling" is enabled, the 30 Hz AM depth is set to be equal to the 9960 Hz sub-carrier AM depth setting as the sub-carrier depth is varied. Similarly, the sub-carrier depth is set to the 30 Hz tone depth when the 30 Hz tone depth is varied. This mode of operation is disabled by pressing the *[Disable Coupling]* key.

Identity channel

VOR signals often carry a morse coded tone to identify the transmitter. This signal can be simulated by selecting the *[Ident/Comms]* key to produce a display similar to the one shown in Fig. B-13.

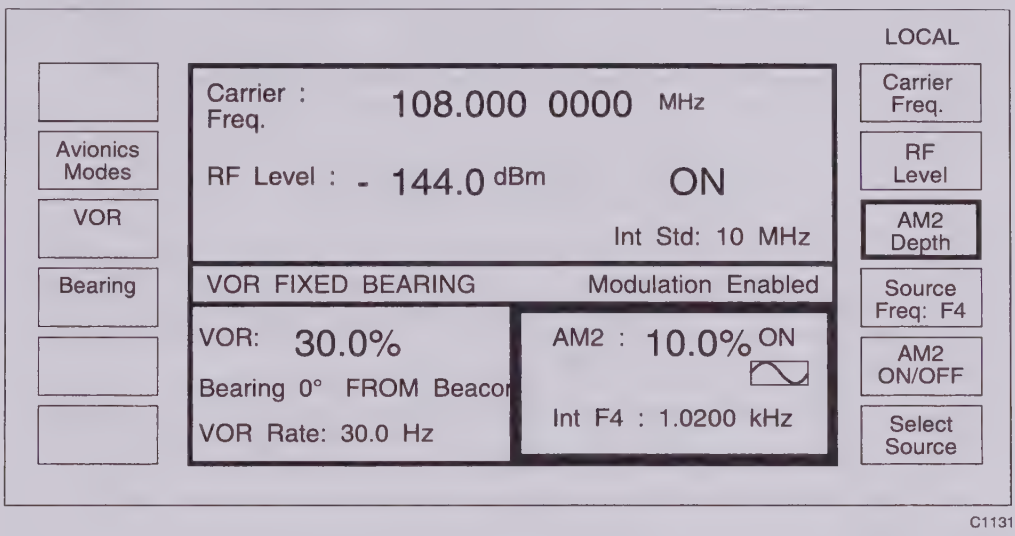

Fig. B-13 Ident/Comms selected

The instrument will generate a VOR signal having equal sub-carrier and 30 Hz tone depths with a 0° bearing. The AM depth displayed is the depth of each tone and can be changed using the *[VOR]* key.

An additional AM signal, AM2, can be added to this waveform. The source of this modulation can be selected using the *[Select Source]* key and if internal modulation has been selected the modulation frequency can be set using the *[Source Freq.]* key. The depth of this additional signal can be set by the *[AM2 Depth]* key.

ADF mode

The ADF mode is selected using the *[ADF]* key on the Avionics Mode Selection Menu shown in Fig. B-3. This menu can be selected from other aviation modes (VOR, ILS, MARKER BEACON, SEL-CAL) using the *[Avionics Modes]* key. Selecting the ADF mode and pressing the [SIG GEN] key produces the display shown in Fig. B-14.

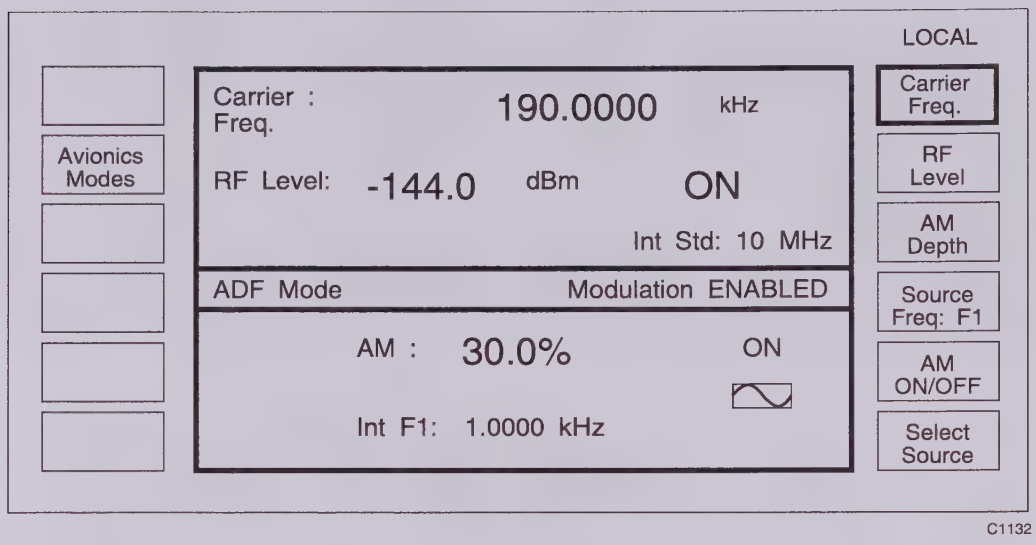

Fig. B-14 ADF mode selection menu

The carrier frequency will default to 190 kHz and the modulation depth to 30% from a 1 kHz source. This setting is used to simulate a long wave transmitter for direction finding purposes. The instrument operation is very similar to non-avionics modes with a single modulation selected (except that FM cannot be selected).

Pressing the *[Avionics Modes]* key returns the display to the Avionics Mode Selection Menu shown in Fig. B-3.

SEL-CAL mode

The SEL-CAL mode can be used to test receivers using AM Selective Calling Tones to the selective calling format. The mode can be selected from the Avionics Mode Selection Menu shown in in Fig B-3. Selecting SEL-CAL mode and pressing the [SIG GEN] key produces the display shown in Fig. B-15.

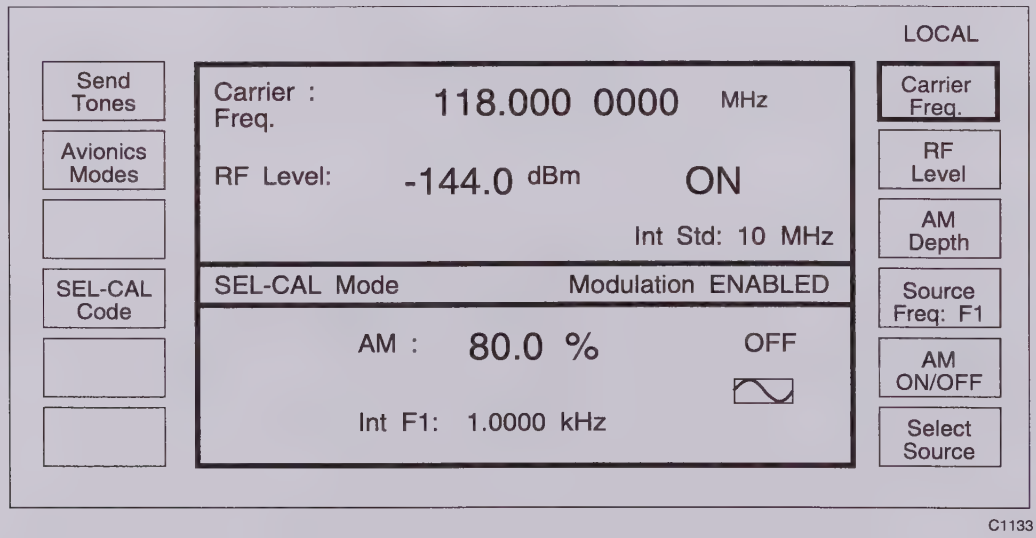

Fig. B-15 SEL-CAL mode selection menu

The instrument operation is similar to that in non-avionics modes with a single modulation selected (except that FM cannot be selected). Carrier frequency and AM depth can be altered, but always default to 118 MHz and 80% respectively.

The SEL-CAL tones can be sent by pressing the *[Send Tones]* key. While the tones are being sent *Modulation ENABLED* is replaced by the message *** *SENDING TONES* *** and the normal modulation tone is suppressed.

The SEL-CAL code can be modified by pressing the *[SEL-CAL Code]* key to produce a display similar to the one shown in Fig. B-16. Operation of this facility is identical to that of the Sequential Calling Tones Utility in non-avionics mode. The tone duration and gap can be set but the default values are those usually used for SEL-CAL. Alternative standards can be selected using the *[Select Standard]* key. The *[Mode Control]* key can be used to change the mode from single shot but the default setting in always single shot.

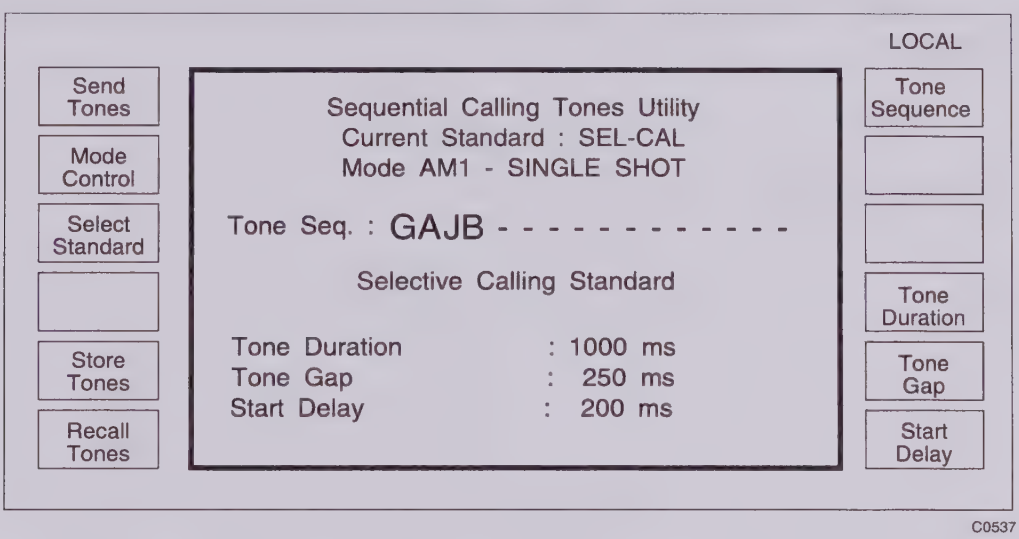

Fig. B-16 SEL-CAL tones utility

Tone sequences are entered using the *[Tone Sequence]* key to produce the display shown in Fig. B-17.

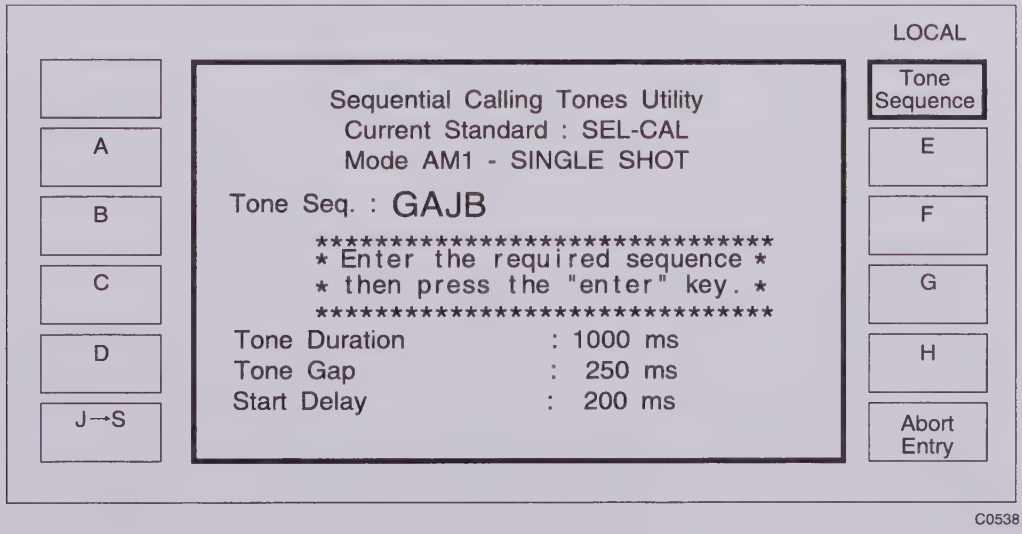

Fig. B-17 SEL-CAL tone entry

Characters A to H may be directly entered. To enter characters J to S first select the key *[J→S]*. An even number of characters is required to be entered up to a maximum of 4 (2 pairs). When the entry is complete terminate the code using the [enter] key. The display will return to that shown in Fig. B-16.

Note...

The SEL-CAL calling tones can also be selected from the Calling Tones utility used for other calling tone standards. In this mode FM is also allowed.

Rotary control

The rotary control can be used to vary major parameters in all Avionics modes by pressing the [KNOB UP-DN] key. The sensitivity of the rotary control can be changed using the [⇑] and [⇓] keys.

GPIB OPERATION

MODE

Set avionics mode
(in addition to existing modulation mode commands)

Data type : Character Program Data (valid combinations of SDM, DDM, VOR, BEAR or AM2, see Table below)

Allowed suffices : None

Default suffix : None

Examples:
```
MODE SDM,DDM (select ILS mode with DDM)
MODE SDM,AM2 (select ILS mode with AM2)
```

VALID MODE COMBINATION TABLE

ILS	VOR
SDM,DDM	VOR,BEAR
SMD,AM2	VOR,AM2

NOTE...

Order is not important, for example SDM,DDM is equivalent to DDM,SDM.

MODE?

Prepares message containing information on Modulation Mode in the following format:

:MODE<mode>
where: <mode> is character program data indicating the modulation mode settings.

Examples:
```
:MODE VOR,BEAR
:MODE SDM,DDM
```

ILS (Instrument Landing System) mode

SDM Set Sum of Depth of Modulation (short form)

:DEPTH Set SDM Depth

:INC Set SDM step size

Data type : Decimal Numeric Program Data
Allowed suffices : **PCT**
Default suffix : **PCT**

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
SDM:DEPTH 40PCT;INC 2;UP;UP;UP
```

SDM? Prepares messages containing information on SDM in the following format:
:SDM:DEPTH <nr2>;INC <nr2>

Example:
```
:SDM:DEPTH 40.0;INC 0.5
```

DDM90 Set Difference in Depth of Modulation with 90 Hz tone predominant (short form)

:DEPTH Set DDM90 Depth

DDM150 Set Difference in Depth of Modulation with 150 Hz tone predominant (short form)

:DEPTH Set DDM150 Depth

DDM90 or DDM150

:INC

Data type : Decimal Numeric Program Data
Allowed suffices : **PCT**
Default suffix : **None**

Note...

When there is no suffix it is assumed that the entry is in DDM index (%/100).

:UP Go UP one step

:DN Go DOWN one step

:RETN Return to original setting

:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
DDM90:DEPTH 40PCT;INC 0.1;DN;DN
DDM150:DEPTH 0.1554;INC 0.0002;UP;UP;UP
```

DDM?

Prepares messages containing information on DDM in the following format:

:<ddm>:DEPTH <nr2>;INC <nr2>

where <ddm> is a program mnemonic indicating the predominant tone (DDM90 or DDM150).

Examples:
```
:DDM90:DEPTH 0.2000;INC 0.01
:DDM150:DEPTH 0.4000;INC 0.01
```

SUPPRESS

[not used alone]

:TONE90	Suppress the 90 Hz tone
:TONE150	Suppress the 150 Hz tone
:NONE	Remove tone suppression

Data type :	None
Allowed suffices :	None
Default suffix :	None

Examples:
```
:SUPPRESS;TONE150
:SUPPRESS:NONE
```

SUPPRESS?

Prepares messages containing information on tone suppression control in the following format:

:SUPPRESS:<status>

where: <status> is a program mnemonic indicating the tone suppresson state.

ILSF

Set ILS Frequency (short form)

:VALUE	Set ILS Frequency
:INC	

Data type :	Decimal Numeric Program Data
Allowed suffices :	**GHz, MHz, KHz, Hz**
Default suffix :	**Hz**

:UP	Go UP one step
:DN	Go DOWN one step
:RETN	Return to original setting
:XFER	Transfer current value to be the new setting

Data type :	None
Allowed suffices :	None
Default suffix :	None

Example:
```
ILSF:VALUE 30 Hz;INC 0.1;DN;DN;DN
```

ILSF?

Prepares messages containing information on ILS Frequency in the following format:

:ILSF:VALUE <nr2>;INC <nr2>

Example:
```
:ILSF:VALUE 30.0;INC 0.5
```

Marker beacon mode

There are no additional commands for marker beacon testing, the required setting is obtained by using the appropriate standard commands.

Example for setting up and sending 400 Hz outer marker beacon:

Example:
```
:CFRQ 75 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
95 PCT;INTF1;ON;:INTF1 400 HZ;:MOD:ON;:MODE AM
```

Example for setting up and sending 1300 Hz middle marker beacon:

Example:
```
:CFRQ 75 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
95 PCT;INTF1;ON;:INTF1 1300 HZ;:MOD:ON;:MODE AM
```

Example for setting up and sending 3000 Hz inner marker beacon:

Example:
```
:CFRQ 75 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
95 PCT;INTF1;ON;:INTF1 3000 HZ;:MOD:ON;:MODE AM
```

VOR (VHF Omnidirectional Radio Range) mode

VOR or SUB — Set SUB Subcarrier Signal (9960 Hz) Depth (short form)

:DEPTH — Set SUB Depth

:INC — Set SUB step size

Data type : Decimal Numeric Program Data
Allowed suffices : **PCT**
Default suffix : **PCT**

:UP — Go UP one step
:DN — Go DOWN one step
:RETN — Return to original setting
:XFER — Transfer current value to be the new setting
:ENABLE — Enable Subcarrier and variable signal depth coupling
:DISABLE — Disable Subcarrier and variable signal depth coupling

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
SUB:DEPTH 30PCT;INC 2;UP;UP;UP
```

VOR? or SUB? — Prepares messages containing information on SUB in the following format:

:SUB:DEPTH <nr2>;INC <nr2>

Example:
```
:SUB:DEPTH 30.0;INC 0.5;DISABLE
```

REF — Set REF Variable Signal (30 Hz) Depth (short form)

:DEPTH — Set REF Depth

:INC — Set REF Step Size

Data type: Decimal Numeric Program Data
Allowed suffices : **PCT**
Default suffix : **PCT**

:UP — Go UP one step
:DN — Go DOWN one step
:RETN — Return to original setting
:XFER — Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
REF:DEPTH 30PCT;INC 2;DN;DN;DN
```

REF? — Prepares messages containing information on REF in the following format:

:REF:DEPTH <nr2>;INC <nr2>

Example :
```
:REF:DEPTH 30.0;INC 0.5
```

BEARTO — Set VOR Bearing To Beacon (short form)

:VALUE — Set VOR Bearing To Beacon

BEARFR Set VOR Bearing From Beacon (short form)
:VALUE Set VOR Bearing From Beacon

BEARTO or BEARFR

:INC

Data type: Decimal Numeric Program Data
Allowed suffices : **DEG**
Default suffix : **DEG**

:UP Go UP one step
:DN Go DOWN one step
:RETN Return to original setting
:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Examples:
```
BEARTO:VALUE 90DEG;INC 0.1;UP;UP;UP
BEARFR:VALUE 270DEG;INC 0.1;DN;DN;DN
```

BEAR? Prepares messages containing information on VOR BEARING in the following format:

:<bear>:VALUE <nr2>;INC <nr2>
where <bear> is a program mnemonic indicating the Bearing convention (BEARTO or BEARFR).

Examples:
```
:BEARFR:VALUE 60.0;INC 0.5
:BEARTO:VALUE 300.0;INC 0.5
```

VORF Set VOR Frequency (short form)
:VALUE Set VOR Frequency
:INC

Data type: Decimal Numeric Program Data
Allowed suffices : **GHz, MHz, KHz, Hz**
Default suffix : **Hz**

:UP Go UP one step
:DN Go DOWN one step
:RETN Return to original setting
:XFER Transfer current value to be the new setting

Data type : None
Allowed suffices : None
Default suffix : None

Example:
```
VORF:VALUE 30Hz;INC 0.1;DN;DN;DN
```

VORF? Prepares messages containing information on VOR Frequency in the following format:

:VORF:VALUE <nr2>;INC <nr2>

Example :
```
:VORF:VALUE 30.0;INC 0.5
```

ADF (Automatic Direction Finder) mode

There are no additional commands for ADF testing, the required setting is obtained by using the appropriate standard commands.

Example:
```
:CFRQ 190 KHZ;RFLV:VALUE +10 DBM;ON;:AM1:
DEPTH 30 PCT;INTF1;ON;:INTF1 1 KHZ;:MOD:ON;:MODE AM
```

Sel-cal mode

SEL-CAL adds the following to the Sequential Calling Tones. SEL-CAL is an additional valid type. The data string representing the Tone Sequence is an even number of characters selected from the set {ABCDEFGHJKLMPQRS}.

Example for setting operating conditions:

Example:
```
:CFRQ 118 MHZ;RFLV:VALUE 0 DBM;ON;:AM1:DEPTH
80 PCT;INTF1;OFF;:INTF1 1 KHZ;:MOD:ON;:MODE AM
```

Example for setting up SEL-CAL and sending tones:

Example:
```
:SEQT:MODE:STD SELCAL;MOD AM1;:SEQT:SEQ
"GABD";SEND 1
```

ACCEPTANCE TESTING

Introduction

The test procedures in this section enable you to verify that the electrical performance of the avionics signal generator complies with the Performance Data given earlier. The test equipment recommended for this purpose is listed in Table B-1. All tests may be performed with the covers in place and are intended to be carried out in the order given. For convenience, the test equipment and specification for each test are summarized before the test procedure. These tests are in addition to those for non-avionics versions of the instrument.

These acceptance tests give a high degree of confidence that the instrument meets its specification, without the use of specialised test equipment.

The avionics option uses a method of Direct Digital Synthesis (DDS) to generate the required avionics waveforms. The accuracy of the generated waveform is therefore determined by stored digital data and the AM performance of the signal generator. These tests check the waveform generation and analogue and RF signal paths in the signal generator. Additional tests can be undertaken using specialised ILS and VOR receivers if they are available.

Test equipment

The test equipment recommended for acceptance testing is shown in Table B-1. Alternative equipment may be used provided it complies with the stated minimum specification.

TABLE B-1 RECOMMENDED TEST EQUIPMENT

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer	DC to 400 MHz Level accuracy ±1 dB	Marconi 2382
Modulation meter	500 kHz to 1 GHz AM accuracy ±1% of reading Selectable ILS filter	Marconi 2305
Oscilloscope	100 MHz bandwidth	Tektronix 2235

Functional testing of ILS waveform generation

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer	100 Hz to 400 MHz	Marconi 2382
Oscilloscope	100 MHz bandwidth	Tektronix 2235

Marconi Instruments uses a method of Direct Digital Synthesis (DDS) to generate the ILS waveforms. One DDS generated waveform contains both the 90 Hz tone and the 150 Hz tone with 0% DDM (Difference Depth of Modulation).

A second waveform is generated with 0% DDM but with the relative phase of the 150 Hz tone reversed compared to that of the 90 Hz tone.

When small levels of the second waveform are added to the first, the resultant waveform has a constant SDM and adding a proportion of the second waveform will result in the DDM of the resultant signal changing.

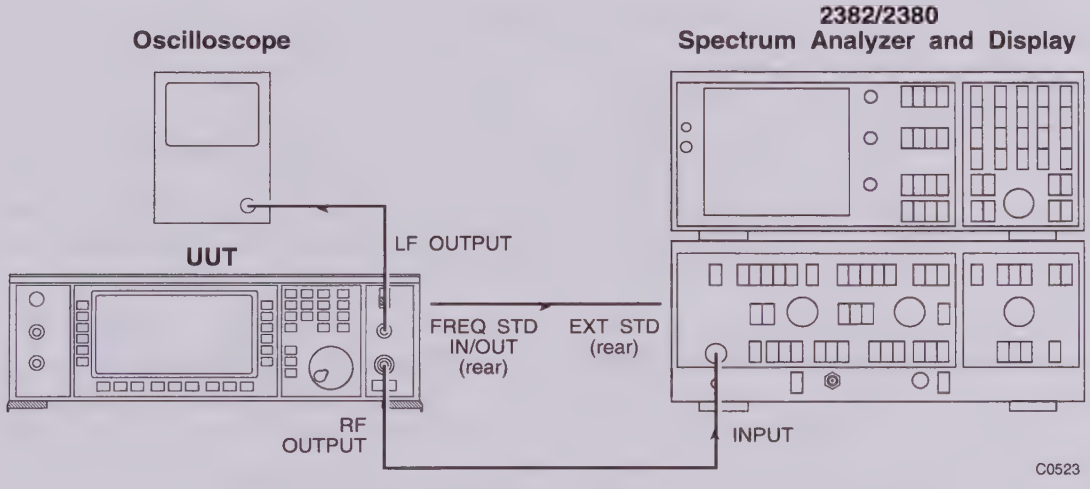

Fig. B-18 ILS functional test set-up

(1) Connect the test equipment as shown in Fig. B-18.

(2) Set up the test equipment as follows:-

Unit under test

ILS Mode

Carrier freq	108.1 MHz
RF level	7 dBm
SDM	40 %
ILS rate	30 Hz
DDM	0 %
90 Hz dominant	Fly RT

Oscilloscope

Volts/div	0.2 V
Time base	5 ms/div

Spectrum analyzer

Preset and calibrate	
Reference frequency	108.1 MHz
Reference level	10 dBm
Span/div	50 Hz
Resolution bandwidth	10 Hz

(3) The typical traces on the oscilloscope and the spectrum analyzer are shown in Figs. B-19 and B-20. These traces are for the 90 Hz and the 150 Hz tones' having equal amplitudes (i.e. 0% DDM).

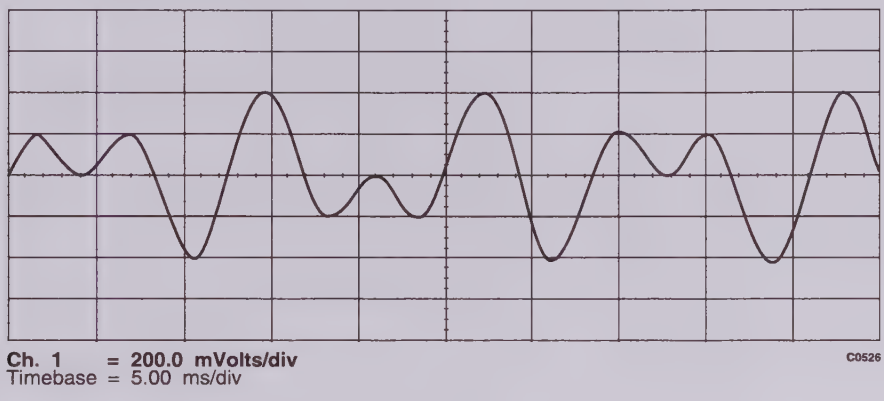

Fig. B-19 Oscilloscope trace for a 0% DDM waveform.

(4) On the UUT reduce the SDM depth using the rotary control. This will cause a reduction in the amplitude of the oscilloscope trace and the sidebands on the spectrum analyzer trace. Reset the SDM to 40%.

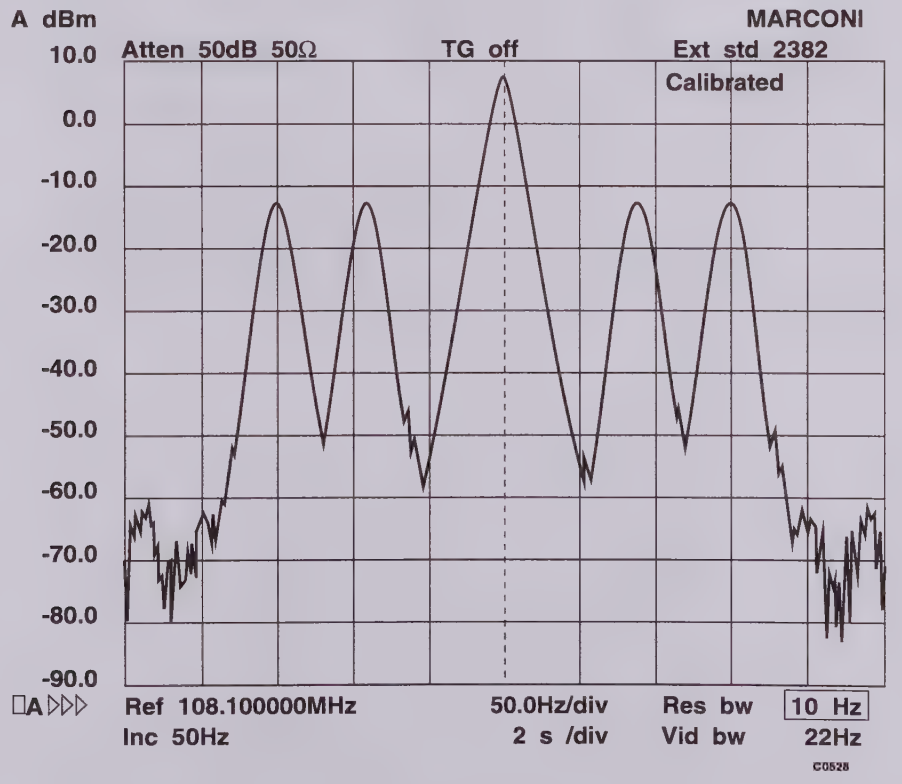

Fig. B-20 Spectrum analyzer trace for a 0% DDM waveform.

(5) On the UUT select DDM. Increase the DDM from 0% to 40% using the knob control. As the change occurs, the 90 Hz sideband should increase and the 150 Hz sideband should decrease. For a signal with a DDM of 40% the 150 Hz sideband will be suppressed as shown in Figs. B-21 (the trace is 2 ms/div) and B-22.

Fig. B-21 Oscilloscope trace for a 40% DDM waveform.

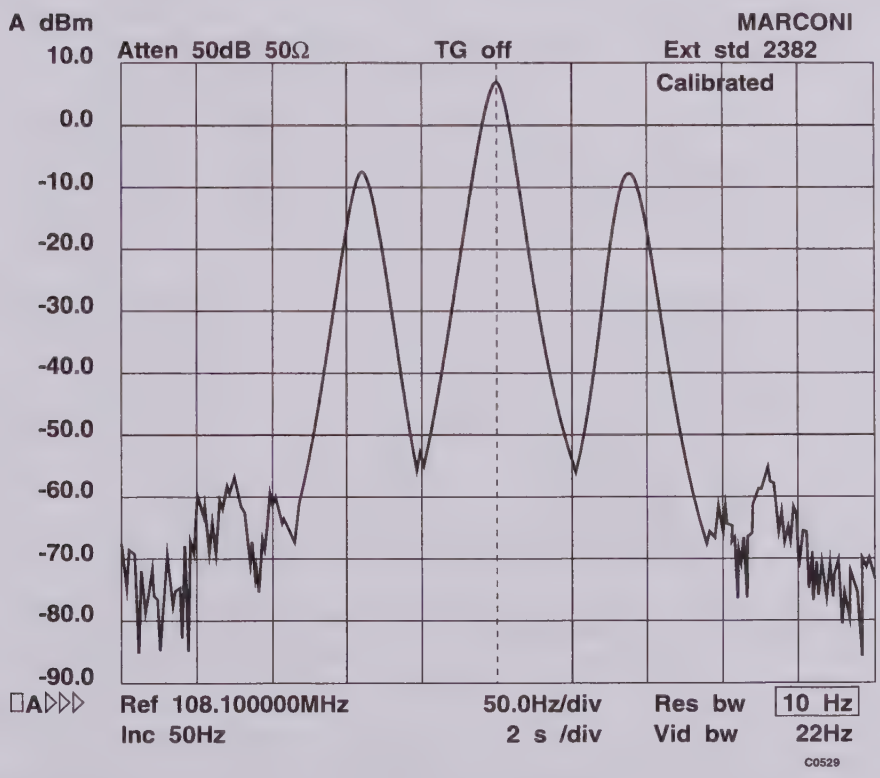

Fig. B-22 Spectrum analyzer trace for a 40% DDM waveform.

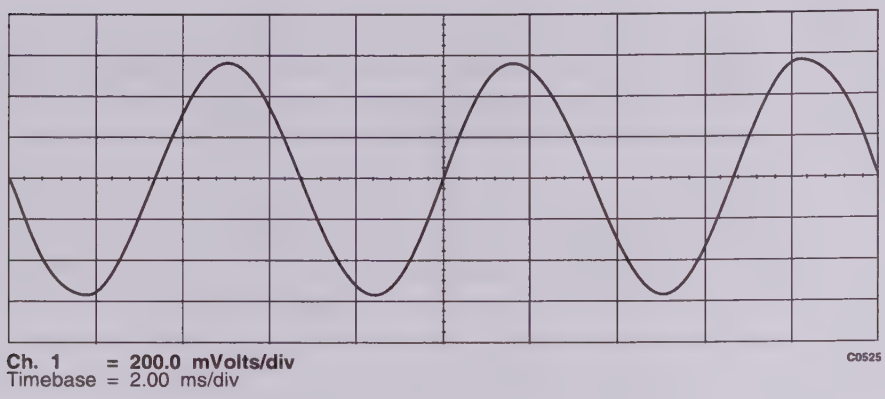

Fig. B-23 Oscilloscope trace for a 150 Hz dominant waveform.

(6) On the UUT select the 150 Hz tone to be dominant. The 90 Hz sideband should be suppressed and the 150 Hz sideband should be present as shown in Figs. B-23 (the trace is 2 ms/div) and B-24.

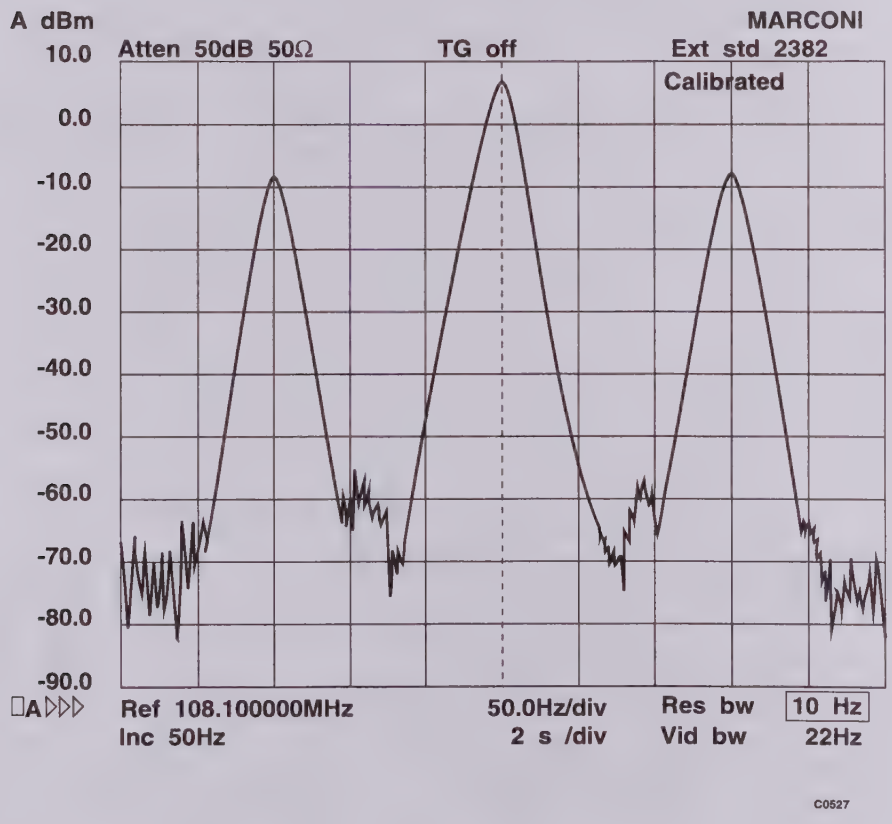

Fig. B-24 Spectrum analyzer trace for a 150 Hz dominant waveform.

Accuracy of SDM (Sum Depth of Modulation) signal path

SPECIFICATION
±2% of setting for carrier frequencies up to 400 MHz

The signal generator has a 1 dB AM bandwidth from DC to at least 30 kHz and consequently the difference in AM response between 90 Hz and 150 Hz will be small and can be neglected. Because of this, it is possible to test the SDM and the DDM accuracy of the instrument by the use of a single tone modulation at 124 Hz rate (the geometric mean of 90 Hz and 150 Hz).

The 0% DDM signal is generated using the AM 1 channel. The phase shifted signal is generated on the AM 2 channel. The design of the instrument ensures that the AM accuracy of each channel at a fixed frequency is equal to the accuracy of the ILS waveform generated by the instrument.

TEST EQUIPMENT

Description	Minimum specification	Recommended
Modulation meter*	50 kHz to 1 GHz AM accuracy ±0.5% of reading at 40% depth ±0.7% of reading at 80% depth Selectable ILS filter	Marconi 2305

*The SDM and DDM accuracy of the Avionics Option can not be verified with a modulation meter calibrated to its published performance specification. A specially calibrated modulation meter is necessary. If more than an approximate verification is required, consult your local MI agent or the Service Division for further details.

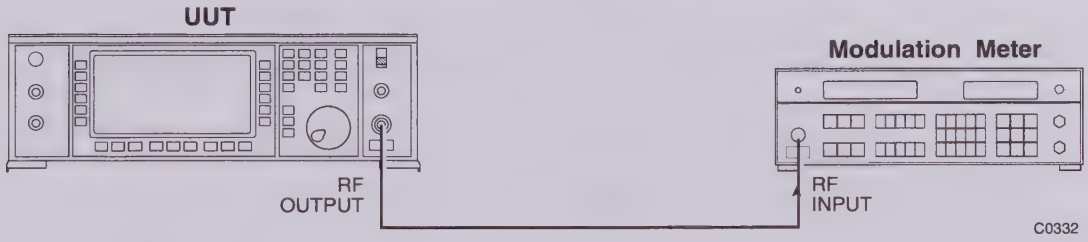

Fig. B-25 Accuracy of SDM signal path test set-up

(1) Connect the test equipment as shown in Fig. B-25.

(2) Set up the test equipment as follows:-

Unit under test

[UTIL] [*Mod'n Mode] [Composite]*
[SIG GEN]
Carrier freq 108.1 MHz
RF level 7 dBm

[AM]
AM 1 depth 40 %
[Select Source] [Internal F1] 120 Hz sinewave
[SIG GEN]
AM 1 Off

AM 2 depth 0 %
[Select Source] [Select Internal] [Internal F2] 124 Hz sinewave
[SIG GEN]
AM 2 Off

Modulation meter

tune Autotune
Function AM
Second function 28 On (see note)

Note...

In order to select second function 28 it is first necessary to unlock the 2305 to its 1st level of protection (this is detailed in the operating manual).

Second function 28 selects an ILS filter. This is a 15 kHz low-pass filter selected separately from, and without any accompanying high-pass section. This provides sufficient high frequency bandwidth for the AM ILS signal without admitting an excessive amount of noise. In the left-hand window a 1 selects the filter and a 0 deselects it.

(3) With AM channels 1 and 2 turned off, allow the modulation meter reading to settle, then measure the residual AM noise and note the reading.

Residual AM noise depth _____%

(4) On the UUT turn the AM 1 channel on. Allow the reading on the modulation meter to settle and note it. (This is equivalent to an SDM of 40 %.)

Measured AM depth _____%

Actual AM depth = Measured AM depth - Residual AM noise

Set AM	Minimum	Actual	Maximum
40%	39.2%	_____%	40.8%

(5) Repeat (4) for an AM 1 depth of 80% (this is equivalent to an SDM of 80%) with the carrier frequency set to 330 MHz.

Set AM	Minimum	Actual	Maximum
80%	78.4%	_____%	81.6%

Accuracy of DDM (Difference Depth of Modulation) waveform

SPECIFICATION
±0.03% of depth ±0.02 of setting

This specification is checked by measuring the modulation channel balance at 19.9% and 40% SDM (with and without final divide-by-5 internal attenuator).

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer or FFT analyzer	DC to 25 kHz 3 Hz filter	Marconi 2382

(1) Connect the test equipment as shown in Fig. B-26.

(2) Set up the test equipment as follows:-

Unit under test

ILS mode

Carrier freq	108.1 MHz
LF output	Monitor AM drive
SDM	40%
DDM	0%
Dominant tone	90 Hz

Spectrum analyzer

Span/div	20 Hz
Frequency	0 to 200 Hz
Ref level	20 dBm
Resolution bandwidth	3 Hz
Input	DC coupled

The spectrum analyzer should display equal amplitude tones of 90 Hz and 150 Hz.

(3) Reset the test equipment as follows:

Unit under test

DDM	40%

The 150 Hz tone should now be suppressed. Check that the residual level is at least 52 dB lower than the 90 Hz tone.

(4) Reset the test equipment as follows:

Unit under test

SDM	19.9%
DDM	19.9%

The 150 Hz tone should still be suppressed. Check that the residual level is at least 52 dB lower then the 90 Hz tone.

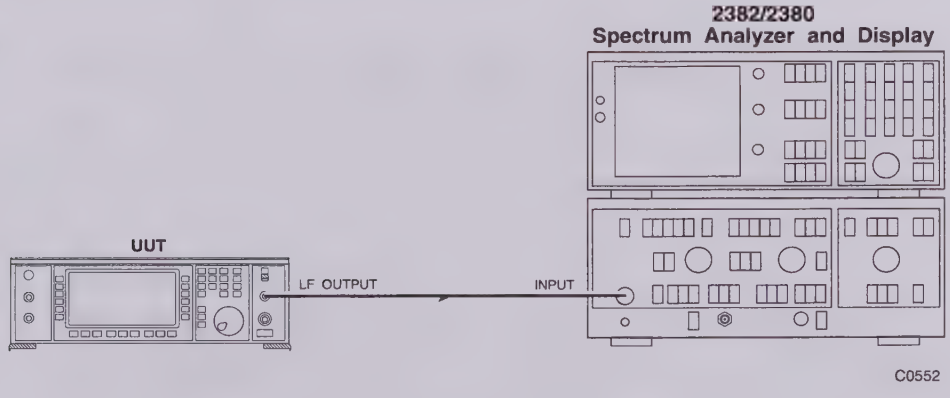

Fig. B-26 Equipment configuration for DDM waveform accuracy

VOR waveform depth accuracy

SPECIFICATION
±3% of setting ±0.5% for carrier frequencies up to 400 MHz

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Modulation meter	Freq range to 400 MHz AM accuracy ±1% of reading Selectable ILS filter	Marconi 2305

(1) Connect the test equipment as shown in Fig. B-25.

(2) Set up the test equipment as follows:-

Unit under test

VOR mode

Carrier freq	108 MHz
RF level	7 dBm
SUB depth	0 %
REF depth	0 %

Modulation meter

Freq tune	108 MHz
Function	AM
Second function 28	On

(3) With SUB and REF set to 0% measure the residual AM noise. Note the reading.

Residual AM noise depth _____%

(4) On the UUT select a SUB depth of 30% and a REF depth of 0%. Allow the reading on the modulation meter to settle and note it.

Measured AM depth _____%

Actual SDM = Measured AM depth - Residual AM noise

Minimum	Actual	Maximum
28.60%	_____%	31.40%

Ensure that the measured depth is in specification.

(5) Repeat (4) for a SUB depth of 0% and a REF depth of 30%.

Minimum	Actual	Maximum
28.60%	_____%	31.40%

(6) Repeat (4) for a SUB depth of 30% and a REF depth of 30%).

Minimum	Actual	Maximum
57.70	_____%	62.30%

VOR waveform test

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Spectrum analyzer or FFT analyzer	DC to 25 kHz 3 Hz filter	Marconi 2382

(1) Connect the test equipment as shown in Fig. B-26.

(2) Set up the test equipment as follows:

Unit under test

VOR mode

SUB depth	30%
REF depth	30%

Spectrum analyzer

Span/div	200 Hz
Ref freq	9.96 kHz
Ref level	10 dBm
Bandwidth	30 Hz

(3) Check that a display similar to that shown in Fig. B-27 is obtained. This shows the presence of the 9.96 kHz sub-carrier with 30 Hz rate, 480 Hz deviation frequency modulation present.

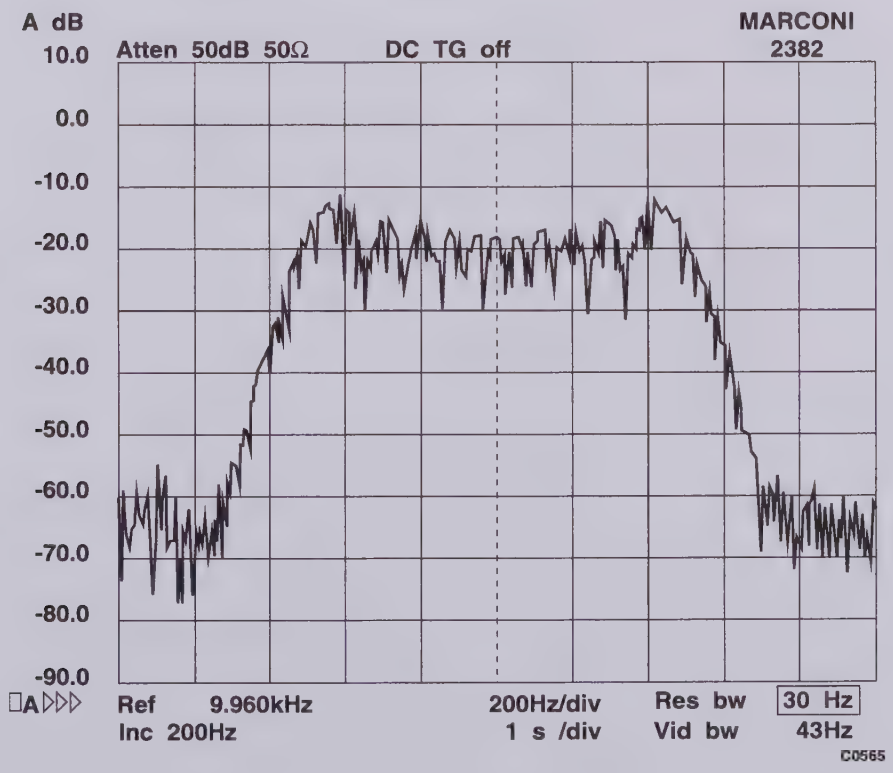

Fig. B-27 9.96 kHz sub-carrier with frequency modulation

Waveform phase control

This test is a functional test of the phase control system used on the DDS sources. The two sources are set to the same frequency and their outputs are summed together. As the relative phase of the source is changed the resulting signal amplitude will change.

TEST EQUIPMENT		
Description	**Minimum specification**	**Example**
Oscilloscope	100 MHz bandwidth	Textronix 2235

(1) Connect the test equipment as shown in Fig. B-28.

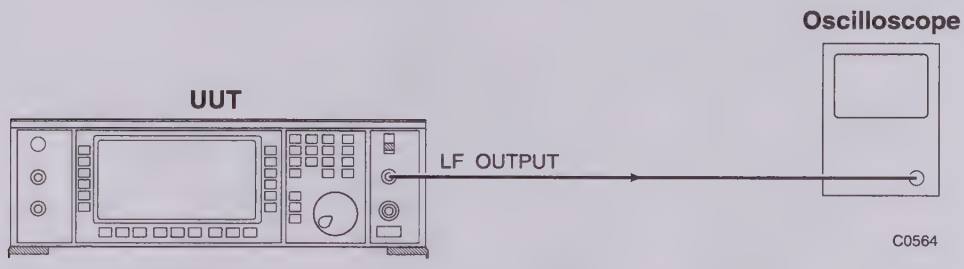

Fig. B-28 Waveform phase control test set-up

(2) Set up the test equipment as follows:

Unit under test

[UTIL] *[Mod'n Mode] [Composite]*
[SIG GEN]

LF output	Modulation monitor
Modulation drive	
AM1	30% ON
AM2	30 % ON
INT F1	30 Hz
INT F2	30 Hz

Set AM1 source to INT F1
Set AM2 source to INT F2

Oscilloscope

Set to monitor LF OUTPUT waveform .

(3) On the UUT select the Internal Source Selection Menu and press the *[Mod. Src Phase]* key. Enter a phase of 0° (to beacon).

Check that the LF OUTPUT is approximately 1.69 V pk-pk.

(4) Enter a phase of 180°. Check that the output tone is substantially suppressed to a level less than 80 mV pk-pk.

(5) Enter a phase of 90° and check that the output tone is approximately 1.2 V pk-pk.

(6) Enter a phase of 270° and check that the output tone has the same amplitude as in (5) above.

Annex D
OPTION 008 RF PROFILES AND COMPLEX SWEEP

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PERFORMANCE DATA

General description

Option 008 software provides additional sweep, RF offset and RF level profiling facilities to support the use of 2030 series Signal Generators with external amplifiers and attenuators. The RF output from the external device can be calibrated and displayed on the front panel of the signal generator using the RF offset and RF profile facilities.

The following specification is in addition to the specification for the 2030 series Signal Generators.

RF OFFSETS

Displayed signal generator output level can be offset by +80 dB to -40 dB from the actual RF output level.

RF offsets may be used in normal signal generator modes or combined with segmented sweeps.

RF PROFILE

RF output level can be adjusted by ±40 dB from its nominal value without changing the displayed RF output level. Ten profiles can be created each containing up to 100 correction points and the RF output level is linearly interpolated between the stored points.
RF profiles can be used in normal signal generator modes or combined with the segmented sweep.

SEGMENTED SWEEP

Carrier frequency sweeps can be generated which contain defined segments each of which can have a different step size, start and stop frequency, step time and RF level.

Start and stop	Start and stop frequency for each segment can be freely defined within the frequency capability of the signal generator.
Step size	Minimum step size is 0.1 Hz. Number of steps is implied by the step size and the start and stop frequencies.
Step time	20 ms to 20 seconds per step.
Segments	Up to 10 segments may be freely combined in any order.

MODULATION WAVEFORMS

Sine, triangle or square wave modulation is available to provide amplitude, phase or frequency modulation.

INTRODUCTION TO OPTION 008

This section describes how to use the additional software features provided when Option 008 RF profile and complex sweep is fitted to a 2030 series Signal Generator. Familiarity with normal operation of the signal generator is assumed.

Option 008 provides two principle facilities. The RF offset facility enables the user to effectively display the RF output level when the signal generator is connected to an external device, such as an attenuator or an amplifier. If the external device gain or loss is frequency dependent then the signal generator can substantially eliminate the frequency dependence using RF profiles.

The segmented sweep facility allows for the generation of sweeps where the sweep is split into segments which can have independent start, stop, step size, step time and RF levels. The complex sweeps are generated using the segmented sweep mode and can be used in combination with the RF profile and RF offset facility. This is particularly useful for electromagnetic immunity and Tempest testing.

Complex sweeps can be generated by combining the RF offset, RF profile and segmented sweep facilities.

RF OFFSET AND PROFILES

These facilities provide the capability for setting the signal generator to display the RF power at the output of a device connected to the signal generator. The RF offset facility is used to compensate for the nominal gain (or loss) of the external device. Adding an offset value does not change the RF output level of the signal generator but does change the displayed RF output level. If, for example, the signal generator is connected to a 20 dB amplifier the offset value can be set to +20 dB. If the signal generator output level is set to +20 dBm then +20 dBm is displayed but the actual signal generator output level will be 0 dBm.

The RF profile facility allows the output level to be corrected to allow for frequency dependent gain (or loss) errors. If, for example, the gain of the amplifier at 100 MHz is 20 dB, at 150 MHz it is 19 dB and at 200 MHz it is 19.5 dB the RF profile facility can introduce 0 dB, 1 dB and 0.5 dB level compensation at 100 MHz, 150 MHz and 200 MHz respectively to compensate for the frequency/gain errors. The RF level profile is linearly interpolated between these frequencies to minimise level errors at intermediate frequencies.

The profile values do not change the displayed RF level but do change the RF output level of the signal generator.

Access to RF offset and profile

The RF offsets and profiles are initially accessed via the *Utilities Selection Menu 2*. To obtain this menu, press **[UTIL].** If the *Utilities Selection Menu 1* is displayed, press the *[Utils. Menu 2]* key. The required display is shown in Figure D-1.

Note...

If the utility facility has already been previously accessed it may be necessary to press the **[UTIL]** key a second time and then select *[Utility Menu 2]*.

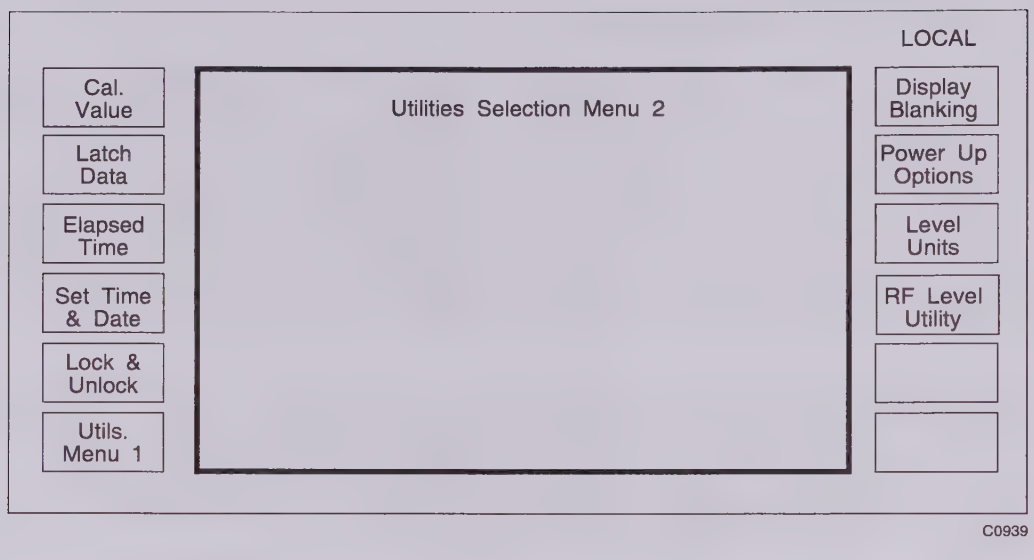

Fig. D-1 Utilities selection menu 2

Press *[RF Level Utility]* to obtain the display shown in Fig. D-2. The *[Offsets]* or *[Profiles]* key can now be selected as required.

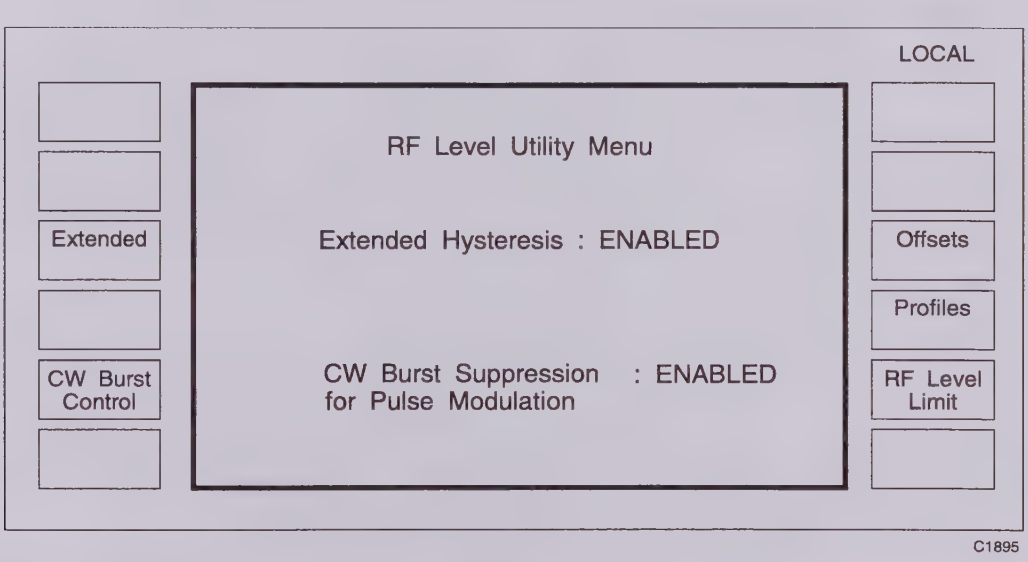

Fig. D-2 RF level utility menu ([CW burst control] and associated text only appears when the relevant option is fitted)

RF OFFSET

Selecting the *[Offsets]* key will result in a display similar to that shown in Fig. D-3. But note that the *[Save Setting]* key will only appear if the instrument has been unlocked to Level 1.

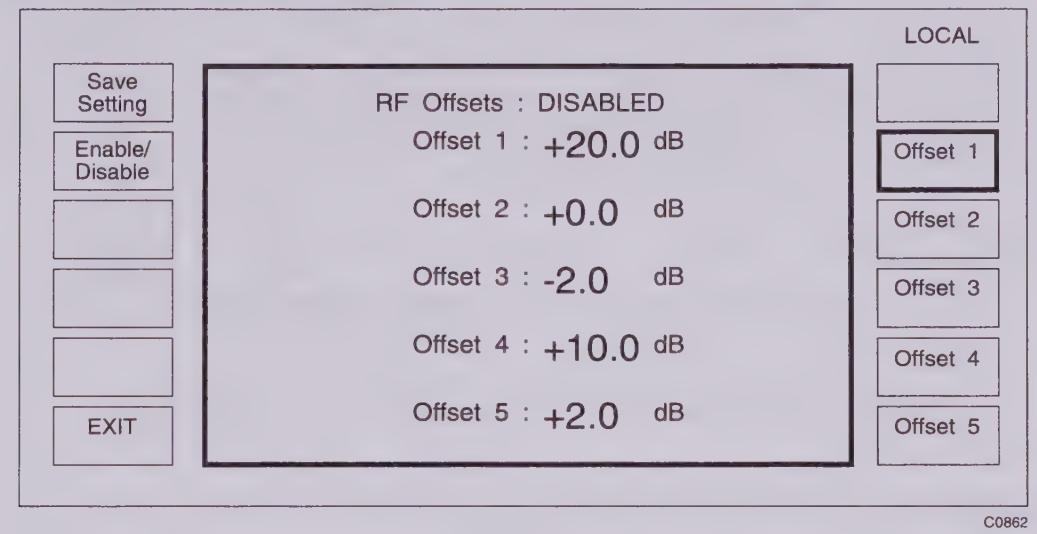

Fig. D-3 RF offset selection (shown unlocked to Level 1)

Selecting one of the *[Offset]* keys will allow an offset of up to +80 dB to -40 dB to be entered using the numerical key pad and the [dB] terminator key. Any of the five offset values may be selected by pressing the appropriate soft key.

The offset values can be changed at any time. The set of values displayed when the instrument is first switched on can also be changed by the user. The generator should be unlocked to Level 1 so that the *[Save Setting]* key is displayed If the offset values are then changed to the required power up settings and the *[Save Setting]* key is pressed the values are stored in non-volatile memory. If the instrument is switched off then when power is restored the saved values of offsets will be automatically recalled and displayed. If the offset values are edited but not saved the edited values will be lost when the instrument is switched off.

The offset facility can be enabled or disabled using the *[Enable/Disable]* key. The state of the Enable/Disable function is stored in non-volatile memory if the *[Save Setting]* key is pressed. If the instrument power is turned off and then on, the stored condition of the Enable/Disable function is recalled.

The RF offset facility can be left by pressing *[EXIT]* to obtain the *RF Level Utility Menu* of Fig. D-2, or by pressing any of the keys underneath the display. If the offset facility is enabled and [SIG GEN] is pressed the main signal generator screen shown in Fig. D-4 is displayed. The display shows that in this example the RF offset facility is enabled and the value of the offset in use is +20 dB. For the set RF level of 0 dBm the signal generator output will be -20 dBm.

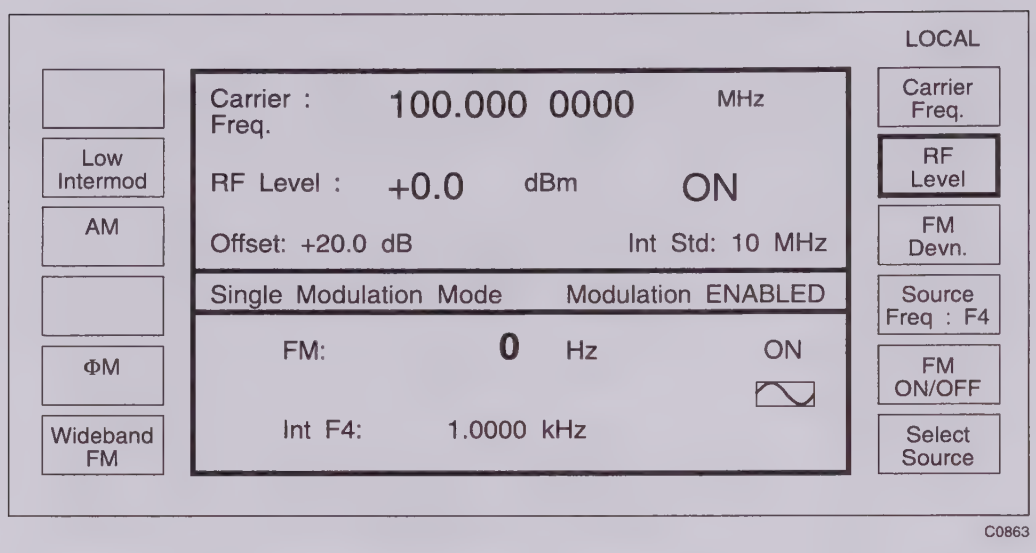

Fig. D-4 Main signal generator screen with RF offset enabled

RF PROFILES

If the *[Profiles]* key is selected from the menu shown in Fig. D-2 the display shown in Fig. D-5 is displayed. But note that the *[Save Setting]* and *[Edit Profile]* keys will only appear if the instrument is unlocked to Level 1.

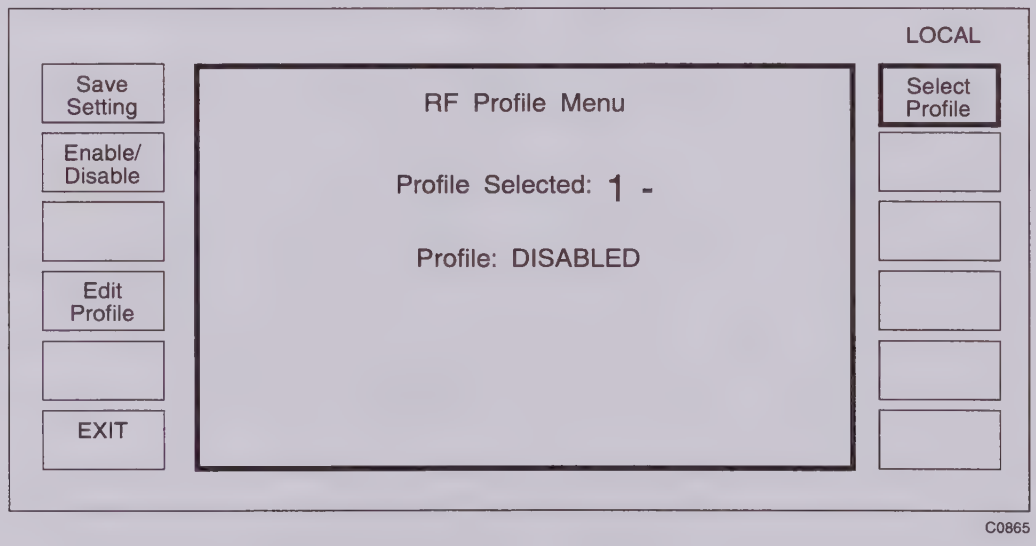

Fig. D-5 RF profile menu (shown unlocked to Level 1)

Up to 10 profiles may be generated and stored using this facility. The profiles are identified as Profile 0 to Profile 9. Each profile can have up to 100 frequencies at which the output level of the signal generator can be adjusted by up to ±40 dB to compensate for the frequency response of an external device without altering the displayed RF level of the signal generator.

Creating a profile

An RF profile editor is provided to create or edit profiles. The instrument must be unlocked to Level 1 in order to use the editor. To use the profile editor press the *[Edit Profile]* key to give the display shown in Fig. D-6.

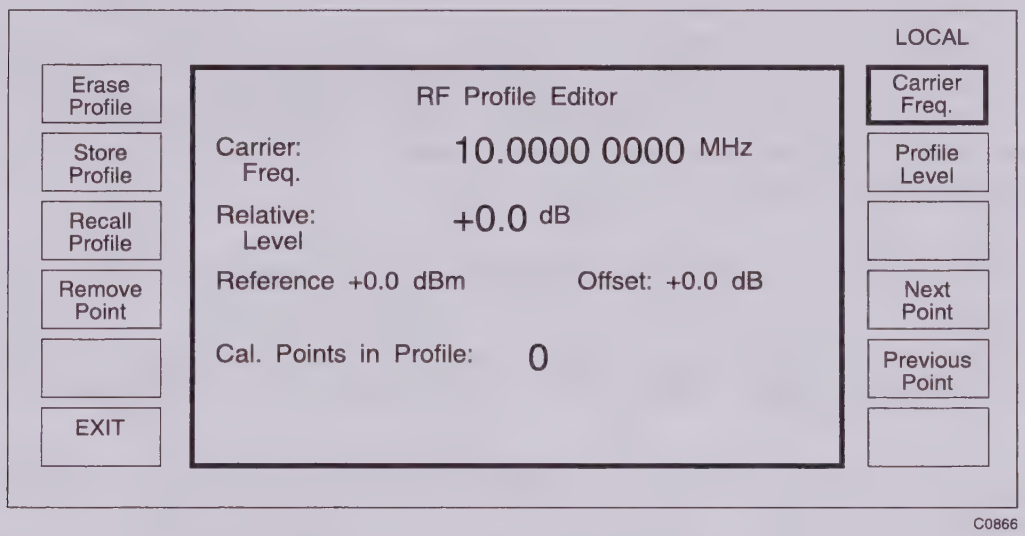

Fig. D-6 RF profile editor menu

The RF offset will only be displayed if an offset value has been selected and enabled. The signal generator's RF level setting is displayed as the reference level.

If the user wishes to edit an existing profile, pressing [Recall Profile] followed by the profile number (0 to 9) and the [enter] key will recall a profile into the editor. A profile can be erased by pressing [Erase Profile] followed by the profile number (0 to 9) and the [enter] key.

Profiles are constructed by entering the carrier frequency at which a correction is to be applied and then adjusting the RF output level until the required setting is obtained. The relative level shows how much the RF level has been adjusted from its nominal value. A positive value of relative level increases the RF output level.

To construct a profile first select the required carrier frequency using the [Carrier Freq.] key. The relative level at that frequency can then be adjusted by pressing *[Profile Level]*. The carrier frequency or profile level can be entered using the keyboard or the rotary control.

When the required value of level has been set up the point is saved using the [Save Point] key which appears in place of the *[Remove Point]* key. The *Cal Points in Profile* display shows how many points form the profile (a profile can have up to 100 points).

When a profile has been constructed (or is being entered) the points can be inspected by using the *[Next Point]* or *[Previous Point]* keys. To make the user aware that a limit has been reached i.e. the first or last point in a profile, the message *At Top Limit* or *At Bottom Limit* is displayed at the top of the screen. Points can be deleted using the *[Remove Point]* key. When *[Remove Point]* has been pressed, an additional key *[Restore Point]* appears. This allows a point which has been accidentally removed to be reinserted.

Points can be added to the profile in any frequency order so that if, for instance, it is found necessary to add a point between two existing points, then when the point is saved the software automatically re-orders the points into an ascending frequency order, and provides interpolation between these points.

Hint:

The rotary control provides a very useful means of editing or creating a profile. If the control is used to adjust carrier frequency while the power at a remote point is monitored, the control gives a good feel for where points should be inserted. The interpolation of the correction data between frequencies results in the most useful location for correction points to be either at or at either side of maximum or minimum values of power.

Note...

If a profile point is added at the same frequency as an existing point in that profile, the old profile level will be automatically overwritten by the new value.

Once two or more points have been entered in a profile the profile can be stored by pressing the *[Store Profile]* key followed by the profile number (0 to 9) and the [enter] key.

Enabling a profile

To enable or disable a profile first use the *[Select Profile]* key shown in Fig. D-5 and enter the profile number (0 to 9) to be used and terminate the entry using the [enter] key.

The *[Enable/Disable]* key can then be used to enable or disable the profile.

The profile facility can be set to be on or off when an instrument is switched on using the save setting facility. If the generator is unlocked to Level 1 pressing the *[Save Setting]* key on the *RF Profile Menu* of Fig. D-5 will result in the state of profile enable/disable flag and the selected profile number being stored in non-volatile memory. If the profile is enabled then at power on the generator will recall the profile and apply it to the RF output.

The RF Profile Menu can be left by using the [EXIT] key to obtain the RF Level Utility Menu of Fig. D-2 or by using the keys underneath the display. If the [SIG GEN] key is pressed to obtain the main signal generator screen, and the profile facility is enabled, the profile selected is displayed as shown in Fig. D-7. The correction value corresponding to the selected carrier frequency will be applied to the RF level.

Note...

Where the carrier frequency is set to a value less then the lowest profile frequency the value at the lowest profile will be used. Similarly if the set carrier frequency is higher than the highest profile frequency the value of the highest profile value will be used.

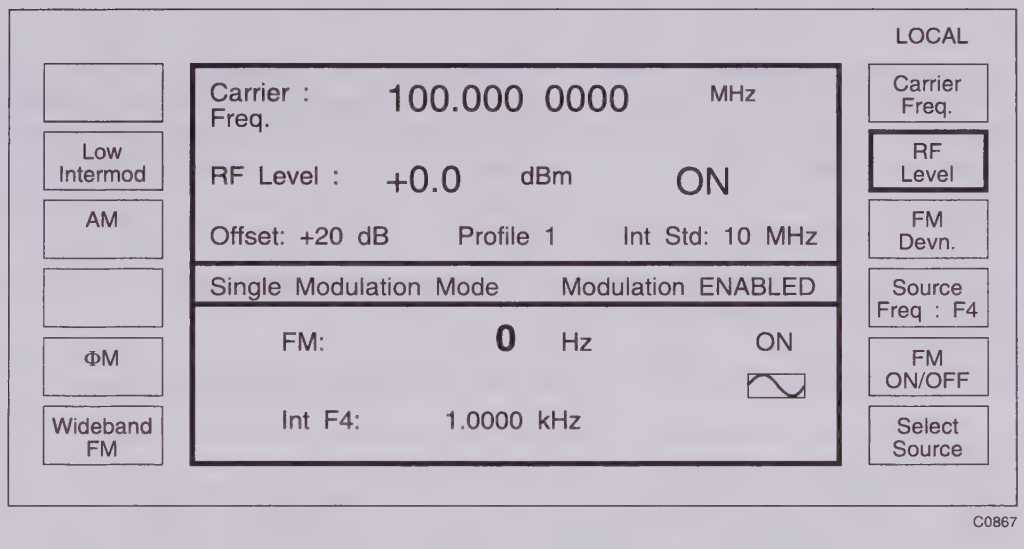

Fig. D-7 Main signal generator screen with RF offset and profiles enabled

TUTORIAL EXAMPLES FOR RF OFFSET AND PROFILES

Example 1: RF offset - compensating for a combiner

Problem:

An application requires the addition of two RF signals with a combiner as shown in Fig. D-8. The combiner has 6 dB insertion loss and it is desirable for the signal generators to display the signal level after the combiner.

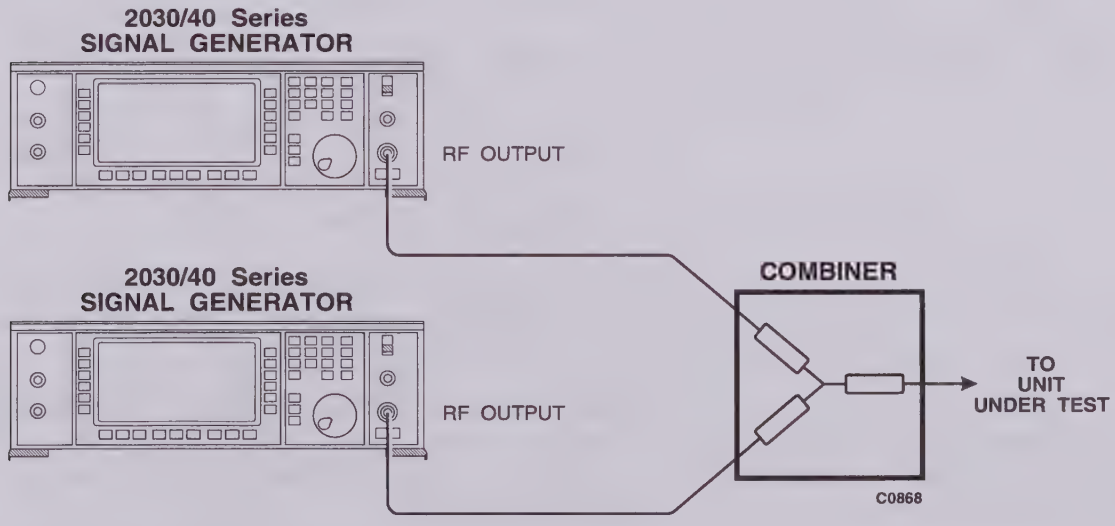

Fig. D-8 Two signal generator testing with a resistive combiner

Solution:

Use the RF offset facility. Set the RF output level (for example to +6 dBm). Then set *Offset 1* (see Fig. D-3) to -6 dB and enable the offset. The signal generators provide outputs of +6 dBm to compensate for the signal loss of the combiner whilst now displaying the signal level after the combiner (in the example 0 dBm) as required.

Note that the maximum displayed RF level will now be limited to +7 dBm since this represents +13 dBm at the RF output connector (unless the overrange facility is enabled).

If the save setting facility is used (Fig. D-3) the generator can be set so that every time it is switched on a -6 dB offset is applied.

Example 2: RF offset and profiles - compensating for an amplifier

Problem:

The signal generator is being used with an external amplifier having a nominal gain of 28 dB. The generator is being used over the frequency range 100 MHz to 500 MHz. Amplifier frequency response and cable losses result in the overall gain of the amplifier system varying between 25 dB and 31 dB. The signal generator is required to display the power at the output of the amplifier.

Solution:

Use both RF offset and RF profile. First use the RF offset facility to enter an offset value of 28 dB (i.e. the mid-point of 25 and 31 dB). Connect a power meter to the amplifier as shown in Fig. D-9 after making sure that the amplifier output is at a level which will not damage the power meter.

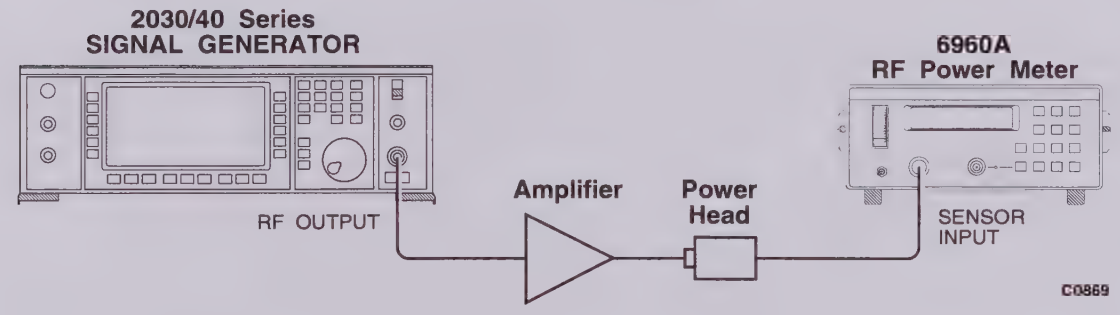

Fig. D-9 Using a signal generator with an external amplifier

A profile can now be added to reduce the frequency dependent RF level errors. With the signal generator level set at (for example) 0 dBm and unlocked to Level 1, select the *RF Profile Editor* shown in Fig. D-6.

Enter a carrier frequency of 100 MHz. Adjust the Profile Level until the power meter reads 0 dBm and then save the point. Repeat for carrier frequencies of 150 MHz, 200 MHz, 250 MHz, 300 MHz, 350 MHz, 400 MHz, 450 MHz and 500 MHz. The profile will now have 9 calibration points entered.

Use the *[Store Profile]* key to store as Profile 0. Exit to the *RF Profile Menu* and select and enable Profile 0.

Press the [SIG GEN] key to obtain the main *Sig Gen* menu. Use the rotary control to vary the carrier frequency between 100 MHz and 500 MHz and check that the power meter reading is acceptably close to 0 dBm. Extra points can be added to the profile if required to reduce errors at intermediate frequencies.

Note...

If the carrier frequency is set (in this example) below 100 MHz or above 500 MHz the error message *Carrier Outside Profile* will be displayed. The profile value at 100 MHz will be applied to the RF output level for frequencies below 100 MHz. Similarly the profile value at 500 MHz will be applied to the RF output level for frequencies above 500 MHz.

SEQUENCE SWEEP

The sequence sweep facility allows sweeps to be defined and generated containing up to 10 segments with independent parameters.

The sweep segments differ from the normal sweep facility on 2030 Series Signal Generators in that the step size is defined rather than the number of steps in a sweep. Each sweep segment can have a different RF level, step size and step time as well as independent start and stop frequencies. A sweep similar to that shown in Fig. D-10 can therefore be generated.

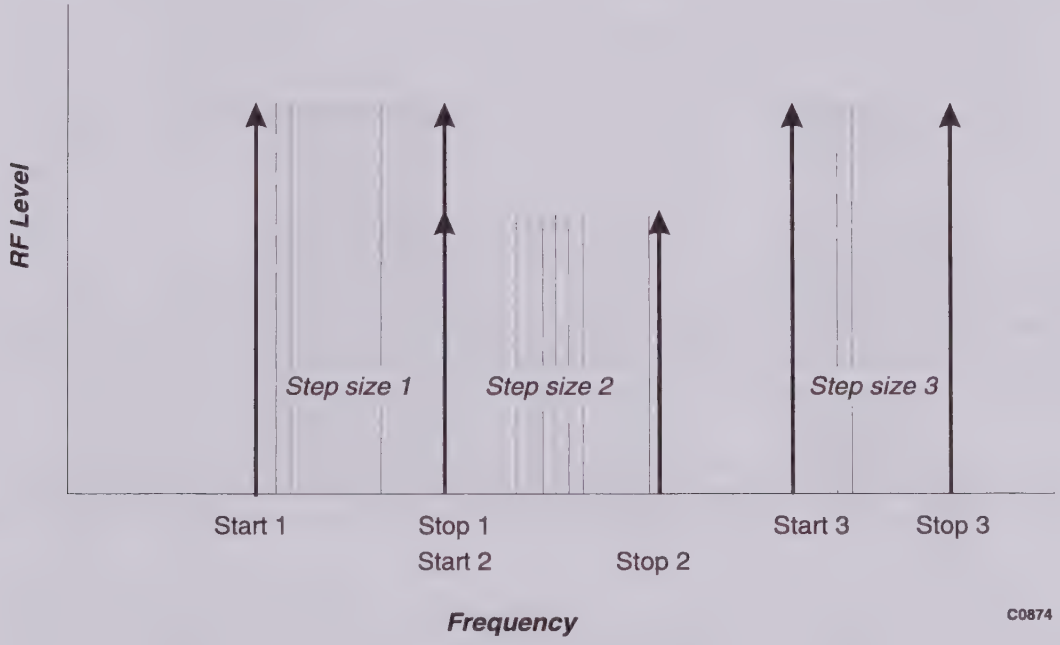

Fig. D-10 Example for a segmented sweep

The segments can be executed in any order. The RF Profile and RF Offset facility can be enabled to correct for the use of external amplifiers and cables.

Selecting a sequence sweep

To enter the Sequence Sweep mode press the [SWEEP] key to obtain the main sweep generator menu. If the last used sweep is not a sequenced sweep press *[Sweep Type]* to obtain the display shown in Fig. D-11, press *[Sweep Sequence]* and use the *[EXIT]* or [SWEEP] key to return to the Sweep Sequence selection menu shown in Fig. D-12.

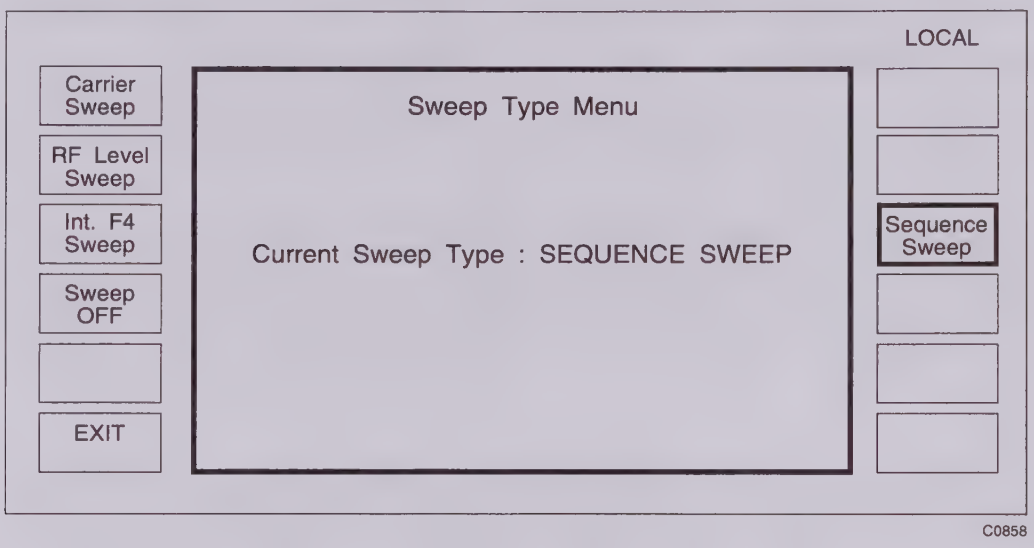

Fig. D-11 Sweep type menu

Note...

RF profiles cannot be applied to the normal carrier sweep provided on the generator. If RF profiles are enabled the *[Carrier Sweep]* key in Fig. D-11 will not be displayed.

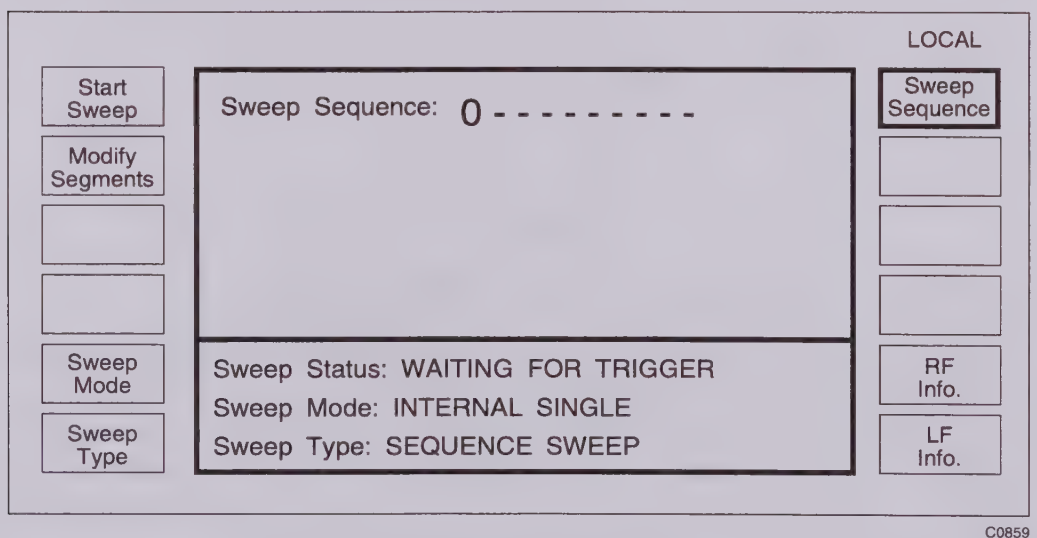

Fig. D-12 Sweep sequence selection menu

Modifying segments

Sequenced sweeps are defined by a series of segments each of which has independent settings. The segments can be constructed from the menu shown in Fig. D-13 called up by pressing the *[Modify Segments]* key.

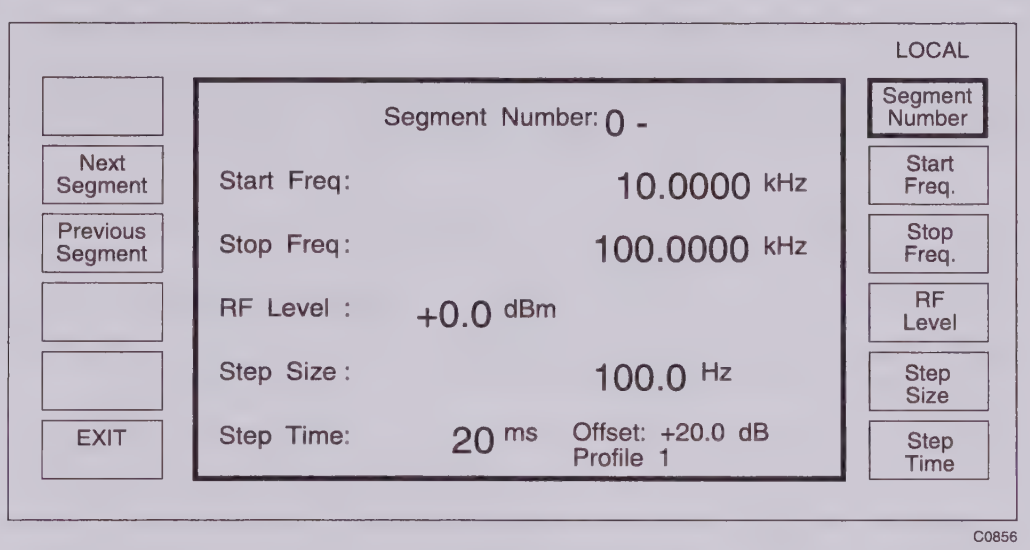

Fig. D-13 Sweep segment editor

Up to 10 segments can be defined as Segments 0 to 9. If an existing segment is to be inspected (or a segment similar to an existing one is required) the segment can be recalled by pressing *[Segment Number]* followed by the segment number (0 to 9) and the [enter] key. Pressing *[Next Segment]* or *[Previous Segment]* will increment or decrement through the segments. For each segment the *[Start Freq.], [Stop Freq.], [RF Level], [Step Size]* and *[Step Time]* keys can be used to define the segment parameters.

Once the user has defined the required segments in a sweep pressing the *[EXIT]* key returns the user to the *Sweep Sequence Selection Menu* shown in Fig. D-12.

Note...

The segment settings are not automatically stored in the non-volatile memory. To store the settings press the [MEM] key. If the memory recall menu is displayed press *[Memory Store]*. Press *[Sweep Store]* followed by the sweep store number (0 to 19) and the [enter] key.

Entering a sweep sequence

From the sweep menu in Fig. D-12 a sweep sequence can be defined by pressing *[Sweep Sequence]* followed by the segment numbers (0 to 9) in the order that they are required to be generated. A minimum of one and a maximum of 10 segments is allowed.

Sweep mode

The *[Sweep Mode]* key can be used to set the sweep to be externally or internally triggered and to be in continuous or single shot mode.

Note...

This is identical to the trigger system used in the other sweep modes.

Starting to sweep

To start a sweep press the *[Start Sweep]* key on the Sweep Sequence selection menu (Fig. D-12). The signal generator will start sweeping and display the current frequency, RF level, step time and the segment number it is currently in. If the sweep has been set to go through a number of segments at different levels the display is updated to show the change of setting.

Before the start of a sweep the RF or LF settings of the generator can be inspected by pressing the *[RF Info.]* or *[LF Info.]* keys.

When a sweep is in progress the sweep can be stopped at any point using the *[Stop Sweep]* key and a display similar to Fig. D-14 will be shown. The carrier frequency and RF level can be varied by using the rotary control.

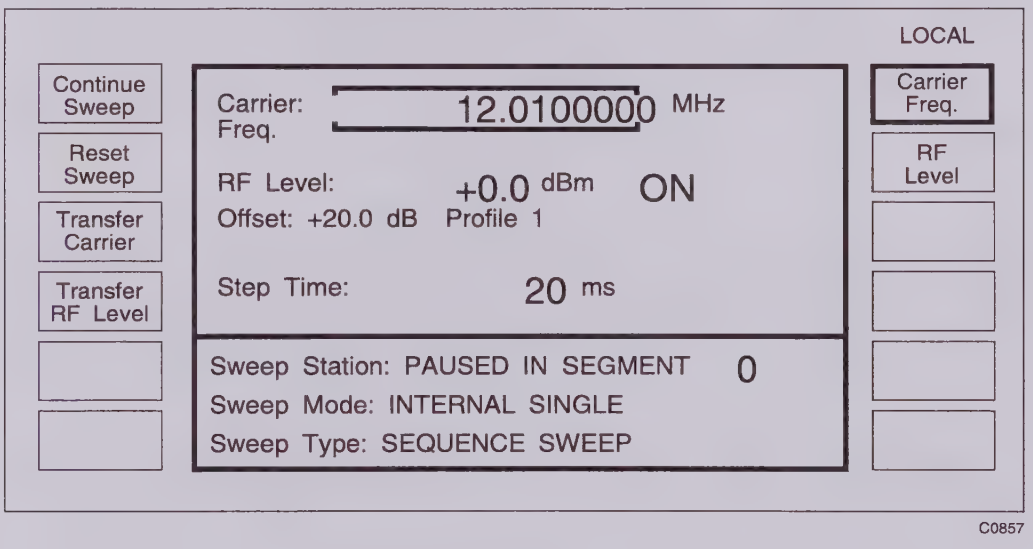

Fig. D-14 Sweep menu display with the sweep halted

Pressing *[Continue Sweep]* will result in the sweep restarting from the same frequency and level as it was stopped at.

Pressing *[Reset Sweep]* will return the sweep to the starting point.

Pressing *[Transfer Carrier]* and/or *[Transfer RF Level]* will transfer the current setting to the main signal generator carrier and RF level settings (obtained by pressing [SIG GEN]).

TUTORIAL EXAMPLES FOR SEQUENCE SWEEP

Example 1: System immunity test

Problem:

A digitally stepped signal is required to test the immunity of a system to RF signals applied at harmonics of the internal clock frequencies of a unit under test. The test requires that the first 20 harmonics are checked and that the signal is swept 10 kHz either side of the nominal clock frequency. The unit under test contains clock frequencies of 8 MHz (for the microprocessor) and 10 MHz.

Solution:

Set the signal generator to provide a frequency modulated signal from the internal triangle source at a rate of 20 Hz and a deviation of 10 kHz.

Use the segmented sweep facility to set up Segment Number 0 to start at 8 MHz with a step size of 8 MHz, a step time of 100 ms and a stop frequency of 160 MHz.

Set up Segment Number 1 to start at 10 MHz with a step size of 10 MHz, a step time of 100 ms and a stop frequency of 200 MHz.

Create a sequence sweep using Segment Number 0 and Segment Number 1. Set the sweep trigger to continuous.

If the sweep is now started it will generate a stepped sweep alternating between harmonics of the 8 MHz and 10 MHz clock and the FM signal will sweep the frequency over a range of ±10 kHz. The FM signal will nominally sweep linearly over the 10 kHz range twice in each direction on each step since the modulation rate is 20 Hz and the step time is 100 ms.

Example 2: Blocking performance test

A radio is being tested for blocking performance. The radio is tuned to 356.55 MHz and uses 12.5 kHz channel spacing. A sweep is required which extends from 10 MHz below the wanted channel to 10 MHz above the wanted channel but excludes the adjacent and next adjacent channels. The RF level is required to be set to -37 dBm during the sweep.

Solution:

Set Segment Number 0 to start at 346.55 MHz, stop at 356.5125 MHz with a step size of 12.5 kHz and a step time to 100 ms to allow enough time for the radio to respond. The RF level should be set to -37 dBm.

Set Segment Number 1 to start at 356.5875 MHz, stop at 366.55 MHz with a step size of 12.5 kHz, a step time of 100 ms and an RF level of -37 dBm.

Set up Segment Number 2 with a start frequency of 356.5125 MHz, a stop frequency of 356.5875 MHz at step size of 100 kHz and a step time of 100 ms. Set the RF level to -144 dBm.

Set up a sequence sweep using Segment Numbers 0, 2 and 1. The signal generator will now sweep from 346.55 MHz to 356.5125 MHz at -37 dBm, then turn the carrier off, step to 356.5875 MHz, turn the carrier on and then sweep to 366.55 MHz as required.

COMPLEX SWEEPS

RF profiles, offset and sequence sweep

The sequence sweep can be combined with the RF profile and RF offset facility to provide a swept signal source where the signal generator displays the RF level at the output of an external frequency dependent amplifier or attenuator.

To set up a sweep of this type use the required sequence sweep, and RF profile and RF offset can be set up as previously described. If the required RF offset and RF profile are then enabled and the sequence sweep selected a complex sweep incorporating all these facilities can be generated.

Suppressing attenuator changes

In addition to being used with RF profiles and RF offsets, sequence sweeps can also be used in conjunction with Extended Hysteresis. Sweeps generated with the Extended Hysteresis mode enabled, will use the modified electronic control facility to apply the RF profiles and to vary the RF output level. Provided the required level does not exceed the Extended Hysteresis electronic control range the mechanically actuated attenuator will not be operated.

Note...

When the -HYST flag is displayed the RF level of the generator is not as accurate as normal modes of operation.

TUTORIAL EXAMPLE FOR IMMUNITY TESTING

Example: Immunity testing in a GTEM cell

Problem:

A device is to be tested to check its immunity to electro-magnetic fields using a GTEM cell. The test requires that the device is tested for field strengths of 10 V/m at frequencies from 1 MHz to 100 MHz and 3 V/m from 100 MHz to 400 MHz. The tests call for checks to be made at 10 kHz intervals from 1 MHz to 30 MHz, 12.5 kHz from 30 MHz to 100 MHz and 100 kHz intervals from 100 MHz to 400 MHz. The GTEM system requires a nominal signal of -10 dBm to drive an amplifier that provides a 10 V/m field strength in the cell.

Solution:

The test requires a combination of the sequence sweep, RF offset and RF profile facilities. In this case the "RF Levels" required at the remote point are field strengths of 10 V/m and 3 V/m. The RF offset facility can be used to convert a nominal signal of -10 dBm to a displayed 10 V PD by using an offset of +43 dB (10 V PD is approximately +33 dBm).

Use a field probe to check the field strength in the GTEM cell. With the generator set to 10 V PD use the RF profile facility to obtain a 10 V/m reading on the field probe for frequencies between 1 MHz and 400 MHz. While creating the RF profile remember that the signal generator software interpolates between profile points so points need to be entered only when the profile slope changes. Store the RF profile produced and check that the field strength is substantially constant as the frequency is changed.

Note...

In this example it is assumed that the RF amplifier is capable of generating a field of 10 V/m at all frequencies and that the amplifier is working in the linear region.

Set up a sequence sweep using segments providing the following characteristics:-

	START	STOP	STEP SIZE	RF LEVEL	STEP TIME
Segment Number 0	1 MHz	30 MHz	10 kHz	10 V PD	100 ms
Segment Number 1	30 MHz	100 MHz	12.5 kHz	10 V PD	100 ms
Segment Number 2	100 MHz	400 MHz	100 kHz	3 V PD	100 ms

Select a sequence sweep using Segment Numbers 0, 1 and 2. With the RF profile and RF offset enabled and the device under test inserted in the GTEM in place of the field probe a swept test can now be undertaken.

The test can be repeated at higher or lower field strength by simply redefining the RF level in the sweep segments.

SQUARE WAVE MODULATION

Generators supplied with Option 008 fitted can generate square wave modulation in addition to the standard sine and triangle waveforms. Square wave modulation can be selected from the main signal generator menu with the modulation set to internal by pressing *[Select Source]* to obtain the *Internal Source Selection Menu* and then pressing *[Square Wave]* to select the square wave modulation source.

The rise and fall times of the square wave are shaped to ensure that minimal overshoot is obtained for AM with frequencies up to at least 2 kHz.

GPIB OPERATION

The following GPIB mnemonics are used to control the RF profile and complex sweep option in addition to those described in Chapter 3-2.

Segmented sweeps

Segmented sweep is a new sweep type which enables the user to set up segments of carrier sweep and store these away in non-volatile memory for future use. Each segment will consist of a START and STOP frequency, RF LEVEL, STEP SIZE and STEP TIME.

A complex sweep can be set up by specifying a sequence of these segments; on completion of sweeping one segment the sweep will jump to the start of the next segment and continue sweeping.

The following GPIB commands are used to provide GPIB control of the segmented sweep.

SWEEP [not used alone]
:TYPE <character program data>
Select type of sweep

Data type: SEQ (Segmented Sweep)
Allowed Suffices: None
Default Suffix: None

SWEEP? Responds with information on Sweep Type and Sweep Mode status as follows:

:SWEEP:TYPE <type>;MODE <mode>

Example: `:SWEEP:TYPE SEQ;MODE SNGL`

SWEEP [not used alone]
:SEQUENCE <string program data>
Select Segmented Sweep Sequence

Data type: String of Segment numbers (0-9) with up to 10 characters between strin
delimiters (e.g. "1238976" or '987665')
Allowed Suffices: None
Default Suffix: None

SWEEP:SEQUENCE? Responds with currently selected Sequence as follows:

:SWEEP:SEQUENCE <string program data>

Example: `:SWEEP:SEQUENCE "5675676543"`

SWEEP [not used alone]

:SEG0
↓ [not used alone]
:SEG9

:<cmd> Select a Segment to edit where <cmd> is replaced by one of the following:

:START Select start frequency
:STOP Select stop frequency
:SIZE Select step size

Data type: Decimal Numeric Program Data
Allowed Suffices: GHZ, MHZ, KHZ, HZ
Default Suffix: HZ

:RFLV Select RF Level

Data type: Decimal Numeric Program Data
Allowed Suffices: DBM, DBV, DBMV, DBUV, V, MV, UV
Default Suffix: DBM unless changed by UNITS command

:TIME Select step time

Data type: Decimal Numeric Program Data
Allowed Suffices: MS
Default Suffix: MS

SWEEP:SEG0?
↓
:SEG9? Responds with parameter settings for segment number specified (0-9) as follows:

:SWEEP:SEG<nr1>:START <nrf>;STOP <nrf>;
RFLV <nrf>;SIZE <nrf>;TIME <nrf>

Example:
```
:SWEEP:SEG2:START 125000000.0; STOP 1750000000.0;
     RFLV -32.4; SIZE 50000000.0; TIME 20
```

:XFER:CW Transfer Paused Carrier value to main parameter

Data type: None
Allowed Suffices: None
Default Suffix: None

:XFER:RFLV Transfer Paused RF Level value to main parameter

Data type: None
Allowed Suffices: None
Default Suffix: None

RF profiles

Used for specifying a level profile over a frequency range. Consists of relative offsets, from a predefined reference level, at user defined frequencies. Linear interpolation is used to calculate the level between frequency points. Up to 10 Profiles can be stored away in non-volatile memory for future use.

These profiles can be used in conjunction with segmented sweeps as well as in NORMAL instrument mode, but not with ordinary frequency carrier sweeps.

The following GPIB commands are used to provide GPIB control of the RF profiles.

PROFILE [not used alone]
:STATUS [not used alone]
:NUM Select Profile (0-9)

Data type: Decimal Numeric Program Data
Allowed Suffices: None
Default Suffix: None

:ENABLE Enable Selected Profile
:DISABLE Disable Selected Profile
:SAVE Store profile setting and status in memory

Data type: None
Allowed Suffices: None
Default Suffix: None

PROFILE:STATUS? Responds with Selected Profile number (0-9) and Status as follows:

:PROFILE:STATUS:NUM <nr1>;<status>

Example: `:PROFILE:STATUS:NUM 4;ENABLE`

To edit a profile, first set the instrument mode to PROFILE

IMODE Select instrument mode

Data type: Character program data (NORMAL, SWEEPER or PROFILE)
Allowed Suffices: None
Default Suffix: None

Example: `IMODE PROFILE`

PROFILE [not used alone]
:EDIT [not used alone]
:CFRQ Set Carrier Frequency

Data type: Decimal Numeric Program Data
Allowed Suffices: GHZ, MHZ, KHZ, HZ
Default Suffix: HZ

:OFFS Set Relative Offset

Data type: Decimal Numeric Program Data
Allowed Suffices: dB
Default Suffix: dB

:SAVE Save profile point

Data type: None
Allowed Suffices: None
Default Suffix: None

:REMOVE Remove a profile point (1 - Number of Points in profile)

Data type: Decimal Numeric Program Data
Allowed Suffices: None
Default Suffix: None

:POINT Select a profile point (1 - Number of Points in profile)

Data type: Decimal Numeric Program Data
Allowed Suffices: None
Default Suffix: None

:ERASE Clear profile in memory (0-9)
:STO Store profile in memory (0-9)
:RCL Recall profile from memory (0-9)

Data type: Decimal Numeric Program Data
Allowed Suffices: None
Default Suffix: None

PROFILE:EDIT:POINT? Responds with Carrier Frequency and Relative Offset for the point requested as follows:

:PROFILE:EDIT:CFRQ <nrf>;OFFS <nrf>

Data type: Decimal Numeric Program Data
Allowed Suffices: None
Default Suffix: None

Example:
```
:PROFILE:EDIT:CFRQ 10000000.0;OFFS -9.9
```

PROFILE:EDIT? Responds with the Number of Points in Profile Editor as follows:

<number of points>

Example:
```
20
```

RF offsets

The GPIB commands for RF LEVEL OFFSETS are as follows:

RFLV

:OFFS	[not used alone]
:NUM	Select RF Offset (1-5)
Data type:	Decimal Numeric Program Data
Allowed Suffices:	None
Default Suffix:	None
:VALUE	Set current RF Offset value
Data type:	Decimal Numeric Program Data
Allowed Suffices:	dB
Default Suffix:	dB
:ENABLE	Enable Selected RF Offset
:DISABLE	Disable Selected RF Offset
:SAVE	Store RF Offsets and status in non-volatile memory
Data type:	None
Allowed Suffices:	None
Default Suffix:	None

RFLV:OFFS? Responds with RF Offset Selected, its Value and its Status as follows:

:RFLV:OFFS:NUM <nr1>;VALUE <nrf>;<status>

Example: `:RFLV:OFFS:NUM 3;VALUE -40.0;ENABLE`

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HEAD OFFICE

Marconi Instruments Ltd
Longacres
ST ALBANS
Hertfordshire AL4 0JN
United Kingdom
Telephone: [+44] (1727) 859292
Fax: [+44] (1727) 857481
Telex: 23350 MARCON G

AUSTRALIA

Marconi Instruments (Pty) Ltd
Unit 1
38 South Street
Rydalmere,
NEW SOUTH WALES, 2116
Australia
Telephone: [+61] (2) 638 0800
Fax: [+61] (2) 638 3131

FRANCE

Marconi Instruments SA
18 Rue du Plessis-Briard
"Le Canal"
Courcouronnes
91023 EVRY CEDEX
France
Telephone: [+33] (1) 60 77 90 66
Fax: [+33] (1) 60 77 69 22
Telex: 690482 F

HONG KONG

Marconi Instruments Ltd.
Room 702-703, CC Wu Building
302-308 Hennessy Road
WANCHAI
Hong Kong
Telephone: [+852] 832 7988
Fax: [+852] 834 5364
Telex: 72369 MINST HX

UK SERVICE DIVISION

Marconi Instruments Ltd
The Airport
LUTON
Bedfordshire LU2 9NS
United Kingdom
Telephone: [+44] (1582) 33866
Fax: [+44] (1582) 417573

GERMANY

Marconi Messtechnik GmbH
Landsberger Strasse 65
D-82110 GERMERING
Germany
Telephone: [+49] (89) 84 9360
Fax: [+49] (89) 84 19142
Telex: 5212642 MMMC D

NETHERLANDS

Marconi Instrumenten
Van Limburg Stirumlaan 4
5037 SK TILBURG
Postbus 645
5000 AP TILBURG
Netherlands
Telephone: [+31] (13) 639540
Fax: [+31] (13) 639663

SINGAPORE

Marconi Instruments
3 Tai Seng Drive
SINGAPORE 1953
Telephone: [+65] 381 1470
Fax: [+65] 281 0113
Telex: 36730 GECSRS RS

SPAIN

Marconi Instrumentos S.A.
Centro Empressarial "El Plantio"
c/Ochandiano, 4 Planta Baja
28023 MADRID
Spain
Telephone: [+34] (1) 372 98 75
Fax: [+34] (1) 307 69 39
Telex: 57481 MIES E

USA

Marconi Instruments Inc.
3 Pearl Court
Allendale
NEW JERSEY 07401
USA
Telephone: [+1] (201) 934 9050
or *Toll Free* 1 800 233 2955
Fax: [+1] (201) 934 9229
Telex: 910 710 991 9752

International Service Centres

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ARGENTINA

RF Instrumentos
Tucuman 358 - 6TO Pisol
(1049) BUENOS AIRES
Republic of Argentina
Telephone: [+54] (1) 311 0424/7432
Fax: [+54] (1) 312 2799
Telex: 21833 JUDD AR

AUSTRALIA

Marconi Instruments (Pty) Ltd
Unit 1
38 South Street
Rydalmere,
NEW SOUTH WALES, 2116
Australia
Telephone: [+61] (2) 638 0800
Fax: [+61] (2) 638 3131

AUSTRIA

LB-Electronics GmbH
Doblinger Haupstrasse 95
A-1190 WIEN
Austria
Telephone: [+43] (1) 367660
Fax: [+43] (1) 3698443

BAHRAIN

Aeradio Technical Services W.L.L.
PO Box 26803
MANAMA
Bahrain
Telephone: [+973] 727790
Fax: [+973] 727811
Telex: 8226 ATS BN

BELGIUM

Marconi Instrumenten
Van Limburg Stirumlaan 4
5037 SK TILBURG
Postbus 645
5000 AP TILBURG
Netherlands
Telephone: [+31] (13) 639540
Fax: [+31] (13) 639663

BRAZIL

ATP Hi-Tek Eletronica Ltda
Alameda Amazonas
422-Alphaville
06400 BARUERI SP
Brazil
Telephone: [+55] (11) 421 5477
Fax: [+55] (11) 421 5032
Telex: 1171413 HITK BR

BRUNEI

Marconi Instruments
ASEAN Regional Centre
GEC Building
3 Tai Seng Drive
SINGAPORE 1953
Telephone: [+673] 381 1470
Fax: [+673] 281 0113
Telex: 36730 GECSRS RS

BULGARIA

GOPE Electronics
45 "Popova Shapka" Str
1505 SOFIA
Bulgaria
Telephone: [+359] (02) 708357
Fax: [+359] (02) 708357

CANADA

Canadian Marconi Company
600 Dr Frederik Philips Boulevard
Ville St Laurent
QUEBEC H4M 2S9
Canada
Telephone: [+1] (514) 748 3000
Fax: [+1] (514) 748 3100

CANADA

Canadian Marconi Company
415 Leggett Drive
PO Box 13330
Kanata
ONTARIO K2K 2B2
Canada
Telephone: [+1] (613) 592 6500
Fax: [+1] (613) 592 7427

CHILE

Morgan & Cia
Miguel Claro 070
Opto 807 Torres de Tajamar
Torre B Providencia
SANTIAGO
Chile
Telephone: [+56] (2) 235 7733
Fax: [+56] (2) 235 7552

CHINA

Marconi Instruments Service Center
Electronics Department
Beijing Institute of Technology
P.O. Box 327
BEIJING 100081
China
Telephone: [+86] (1) 841 6688 ext 2618
Telex: 22011 BIT CN

CHINA

Careri-Marconi Instruments Service Station
424 Huaihai Road West
SHANGHAI 200052
China
Telephone: [+86] (21) 523119 ext 395 or
[+86] (21) 523633
Fax: [+86] (21) 251 2662
Telex: 33390 AEROS CN

COLOMBIA

Telectrónica Limitida
Carrera 13,
Nr 48-47 Piso 8°
Santafe Bogotá, D.C.
Colombia
Telephone: [+57] (1) 2325886,
2327816 or 2876136
Fax: [+57] (1) 2878589

COSTA RICA

Soni Vision S.A.
Apartado 620-1000
SAN JOSE
Costa Rica
Telephone: [+506] 31 3055 or 31 5685
Fax: [+506] 31 6531
Telex: 2645 ELEPEX CR

CZECH REPUBLIC

EMPOS s.r.o.
Rostislavova 13
140 00 PRAHA 4
Czech Republic
Telephone: [+42] (2) 692 50 80
Fax: [+42] (2) 692 50 84

DENMARK

Stantronic Instruments
Ormhøjgårdvej 16
DK 8700 HORSENS
Denmark
Telephone: [+45] 75 643366
Fax: [+45] 75 644080

FIJI

AWA Compac Communication Pacific Ltd
37 Freeston Road
Walu Bay
Suva P.O. Box 858
SUVA
Fiji
Telephone: [+679] 312744
Fax: [+679] 300379
Telex: 2347 AWA FIJI FS

FINLAND

Kaukomarkkinat Oy
Kutojantie 4
SF-02630 ESPOO 63
Finland
Telephone: [+358] (0) 5211
Fax: [+358] (0) 521 6641
Telex: 124469 KAUKO SF

FRANCE

Marconi Instruments SA
18 Rue du Plessis-Briard
"Le Canal"
Courcouronnes
91023 EVRY CEDEX
France
Telephone: [+33] (1) 60 77 90 66
Fax: [+33] (1) 60 77 69 22
Telex: 604482 F

GERMANY

Marconi Messtechnik GmbH
Landsberger Strasse 65
D-82110 GERMERING
Germany
Telephone: [+49] (89) 84 9360
Fax: [+49] (89) 84 19142
Telex: 5212642 MMMC D

GREECE

Telecom Hellas Ltd
116 El Venizelou Avenue
GR 176 76 Kallithea
ATHENS
Greece
Telephone: [+30] (1) 959 7166
Fax: [+30] (1) 957 1994

HONG KONG

GEC Hong Kong Ltd
Room 702-703, CC Wu Building
302-308 Hennessy Road
WANCHAI
Hong Kong
Telephone: [+852] 832 7988
Fax: [+852] 834 5364
Telex: 73098 G HONG HX

HUNGARY

MTA-MMSZ Ltd
59-61 Etele ut
H-1119 BUDAPEST
Hungary
Telephone: [+36] (1) 1869 589
Fax: [+36] (1) 1611 021
Telex: 225114 MTAMM H

ICELAND

Amundason HF
Langhortsuegi 109
104 REYKJAVIK
Iceland
Telephone: [+354] (1) 687820
Fax: [+354] (1) 681180
Telex: 2108 AMCO IS

INDIA

Aimil Sales & Agencies Pvt Ltd
Naimex House
A-8 Mohan Co-operative Ind. Est.
Mathura Road
NEW DELHI 110 044
India
Telephone: (11) 683 7281
Fax: (11) 644 8660
Telex: (31) 75020 AIML IN

INDIA

Aimil Sales & Agencies Pvt Ltd
Badami Mansions
44 Millers Road
BANGALORE 560 052
India
Telephone: [+91] (80) 2265 954
Fax: [+91] (80) 2267 437
Telex: 084 58269 AIML IN

INDONESIA

P.T. Centronix
36 Jalan Matraman Raya
JAKARTA 13150
Indonesia
Telephone: [+62] (21) 884187
Fax: [+62] (21) 8580555
Telex: 48216 CENT JKT

IRAN

Zaeim Electronic Ind. Co. Ltd
PO Box 14155-1434
Niloo Street
No 21 Zaeim Building
Vanak Square
TEHRAN
Iran
Telephone: [+98] (21) 226 1214/15
Fax: [+98] (21) 226 6455
Telex: 212997 ZEIM IR

IRELAND

Neltronic Ltd
John F. Kennedy Road
Nass Road
DUBLIN 12
Eire
Telephone: [+353] (1) 503560
Fax: [+353] (1) 552789
Telex: 93556 NELT EI

ISRAEL

IES Electronics Agencies (1986) Ltd
50 Betzalel Street
RAMAT GAN 52521
Israel
Telephone: [+972] (3) 752 6333
Fax: [+972] (3) 751 0927
Telex: 361396 IES IL

ITALY

Marconi SpA
Via Palmanova, 185
20132 MILANO
Italy
Telephone: [+39] (2) 256 3141
Fax: [+39] (2) 256 7745
Telex: 311467 MARCON I

ITALY

Marconi SpA
Via Campo Nell'Elba 3/5 Instruments
00199 ROME
Italy
Telephone: [+39] (6) 886 931
Fax: [+39] (6) 886 3963
Telex: 626189 MARCON I

JAPAN

Kikusui Electronics Corp.
NISSO the 15th Bldg. 8F
No.2-17-19, Shin-Yokohama
Koh-hoku-ku, Yokohama City
KANAGAWA PREF., 222
Japan
Telephone: [+81] (45) 475 1112
Fax: [+81] (45) 475 1115
Telex: J36475 KECJPN

KENYA

GPT Kenya Ltd
Uhuru Highway
P.O. Box 40743
NAIROBI
Kenya
Telephone: [+254] (2) 555011
Fax: [+254] (2) 541556
Telex: 24053

KOREA

Zino International
Youngsung Bldg.
108-4 Samsung-dong
Kangnam-ku
SEOUL 135 091
Republic of Korea
Telephone: [+82] (2) 545 7334
Fax: [+82] (2) 545 7335

KUWAIT

Al-Nawasi Trading & Contracting Co.
PO Box 3204
13033 SAFAT
Kuwait
Telephone: [+965] 244 7243
Fax: [+965] 241 0473
Telex: 22131 AAA KT

LEBANON

Mabek
P.O. Box 13-5657
BEIRUT
Lebanon
Telephone: [+961] (1) 864479
Fax: [+961] (1) 603129
Telex: 22889 MABEK LE

LICHTENSTEIN

Computer Controls A.G.
Probuswèg 2
8057 ZURICH
Switzerland
Telephone: [+41] (1) 313 0616
Fax: [+41] (1) 313 0622

LUXEMBOURG

Marconi Instrumenten
Van Limburg Stirumlaan 4
5037 SK TILBURG
Postbus 645
5000 AP TILBURG
Netherlands
Telephone: [+31] (13) 639540
Fax: [+31] (13) 639663

MALAWI

Business Machines Limited
P.O. Box 5095
Chilembwe House
Churchill Road
LIMBE
Malawi
Telephone: [+265] 640 088
Telex: [+265] 4218 ERANTHIS

MALAYSIA

The General Electric Company of
Malaysia Sdn Bhd.
Jalan 215-Templer
PO Box 225
Jalan Sultan
46720 PETALING JAYA
Malaysia
Telephone: [+60] (3) 791 1388
Fax: [+60] (3) 791 21350 or
[+60] (3) 791 1886
Telex: 37617 GECMYA MA

NAMIBIA

Measuretest cc
P.O. Box 6301
DUNSWART 1508
Transvaal
Republic of South Africa
Telephone: [+264] (11) 894 7721
Fax: [+264] (11) 894 6414
Telex: 747651 MTEST SA

NEPAL

AIMIL Sales & Agencies Pvt Ltd
Naimex House
A-8 Mohan Co-operative Ind. Est.
Mathura Road
NEW DELHI 110 044
India
Telephone: [+977] (11) 683 7281
Fax: [+977] (11) 644 8660
Telex: (31) 75020 AIML IN

NETHERLANDS

Marconi Instrumenten
Van Limburg Stirumlaan 4
5037 SK TILBURG
Postbus 645
5000 AP TILBURG
Netherlands
Telephone: [+31] (13) 639540
Fax: [+31] (13) 639663

NEW ZEALAND

Components & Instrumentation N.Z. Ltd
P.O. Box 38099
Wellington Mail Centre
19-21 Pretoria Street
LOWER HUTT
New Zealand
Telephone: [+64] (4) 566 3222
Fax: [+64] (4) 566 3722

NIGERIA

GPT (West Africa) Ltd
26 Creek Road
P.O. Box 1009
APAPA
Nigeria
Telephone: [+234] (1) 803230
Fax: [+234] (1) 870591
Telex: 21385

NORWAY

Nortronicom a/s
P.O. Box 33
Manglerud
0612 OSLO 6
Norway
Telephone: [+47] (22) 68 09 10
Fax: [+47] (22) 68 18 87
Telex: 77140 NM M

OMAN, SULTANATE OF

Suhail & Saud Bahwan
PO Box 169
MUSCAT
Sultanate of Oman
Telephone: [+968] 793741
Fax: [+968] 796158
Telex: 3585 BAHWAN ON

PAKISTAN

Intermark Ltd
P.O. Box 6159
Hakimsons Building
19 West Wharf Road
KARACHI 74000
Pakistan
Telephone: [+92] (21) 201725
Fax: [+92] (21) 231 04801
Telex: 23649 YAQIN PK

PHILIPPINES

Sunley Ltd
MCPO Box 2850
Makati, 1299
METRO MANILA
Philippines
Telephone: [+63] (2) 815 1092
Fax: [+63] (2) 815 0730

POLAND

Interlab P.U.H.
Ul. Potocka 14, PAW 3
01-641 WARSAW
Poland
Telephone: [+48] (22) 335454 or 333956
Fax: [+48] (22) 3332260 OR 333956

PORTUGAL

Pinto Basto Electrotecnia e Maquinas Ltda
Av. 24 de Julho
3-1 Esq
1200 LISBON
Portugal
Telephone: [+351] (1) 3972041
Fax: [+351] (1) 3972595
Telex: 16819 SOCIL P

QATAR

Business Communications Qatar Ltd
PO Box 150
DOHA
Qatar
Telephone: [+974] 325851
Fax: [+974] 414100
Telex: 4219 JAIDAH DH

SABAH

The General Electric Company of
Malaysia Sdn Bhd.
Jalan 215-Templer
PO Box 255
Jalan Sultan
46720 PETALING JAYA
Malaysia
Telephone: [+60] (3) 791 1388
Fax: [+60] (3) 791 1883
Telex: 37617 GECMYA MA

SARAWAK

The General Electric Company of
Malaysia Sdn Bhd.
Jalan 215-Templer
PO Box 255
Jalan Sultan
46720 PETALING JAYA
Malaysia
Telephone: [+60] (3) 791 1388
Fax: [+60] (3) 791 1883
Telex: 37617 GECMYA MA

SAUDI ARABIA

Electronic Equipment Marketing Co
P.O. Box 3750
RIYADH 11481
Kingdom of Saudi Arabia
Telephone: [+966] (1) 477 1650
Fax: [+966] (1) 478 5140
Telex: 401120 ZUHAIR SJ

SINGAPORE

Marconi Instruments
ASEAN Regional Centre
GEC Building
3 Tai Seng Drive
SINGAPORE 1953
Telephone: [+65] 381 1470
Fax: [+65] 281 0113
Telex: 36730 GECSRS RS

SLOVAKIA REPUBLIC

EMPOS s.r.o.
Rostislavova 13
140 00 PRAHA 4
Czech Republic
Telephone: [+38] (2) 692 50 80
Fax: [+38] (2) 692 50 84

SOUTH AFRICA

Measuretest cc
P.O. Box 6301
DUNSWART 1508
Transvaal
Republic of South Africa
Telephone: [+27] (11) 894 7721
Fax: [+27] (11) 894 6414
Telex: 747651 MTEST SA

SOUTH AMERICA

Marconi Instruments
Latin American Division
451 West Cyprus Creek Road
Crown Center Suite 300
FORT LAUDERDALE
Florida 33309, USA
Telephone: [+1] (305) 491 4188
Fax: [+1] (305) 491 0511

SPAIN

Marconi Instrumentos S.A.
Centro Empressarial "El Plantio"
c/Ochandiano, 4 Planta Baja
28023 MADRID
Spain
Telephone: [+34] (1) 372 98 75
Fax: [+34] (1) 307 69 39
Telex: 57481 MIES E

SWEDEN

Pronesto AB
Box 6014
164 06 KISTA
Sweden
Telephone: [+46] (8) 632 65 70
Fax: [+46] (8) 751 41 11
Telex: 19270 PROS

SWITZERLAND

Computer Controls AG
Probusweg 2
8057 ZURICH
Switzerland
Telephone: [+41] (1) 313 0616
Fax: [+41] (1) 313 0622

TAIWAN

Hwa Jeat Corp.
6F-3, No. 181
Fu-Hsing N. Road
TAIPEI 10441
Taiwan
Telephone: [+886] (2) 717 3627 or
[+886] (2) 717 4655
Fax: [+886] (2) 719 2886

THAILAND

Yip in Tsoi & Jacks Ltd
523 Mahaprutharam Road
P.O. Box 2611
BANKOK 10501
Thailand
Telephone: [+66] (2) 236 5730
Fax: [+66] (2) 236 5693
Telex: 82929 YIPJACKS TH.

TURKEY

Orko Mumessillik
Tunus Caddesi 85/9
06680 Kavaklidere
ANKARA
Turkey
Telephone: [+90] (312) 426 6047
Fax: [+90] (312) 426 6180
Telex: 44498 OKAS TR

UAE ABU DHABI

Business Communications UAE (Pte) Ltd
P.O. Box 2534
ABU DHABI
United Arab Emirate
Telephone: [+971] (2) 720646
Fax: [+971] (2) 782702
Telex: 22457 BCLAH EM

UAE DUBAI

Business Communications UAE (Pte) Ltd
P.O. Box 233
DUBAI
United Arab Emirate
Telephone: [+971] (4) 225135/6/7 or
[+971] (4) 220186/7/8
Fax: [+971] (4) 236193
Telex: 47631 DUTEN EM

UNITED KINGDOM

Marconi Instruments Ltd
The Airport
LUTON
Bedfordshire LU2 9NS
United Kingdom
Telephone: [+44] (582) 33866
Fax: [+44] (582) 417573

URUGUAY

Pellmar S.A.
Casilla Corres 6125
Piedras 676
MONTEVIDEO
Uruguay
Telephone: [+598] (2) 962017
Fax: [+598] (2) 961991
Telex: 26685 PELMA UY

USA

Marconi Instruments Inc.
3 Pearl Court
Allendale
NEW JERSEY 07401
USA
Telephone: [+1] (201) 934 9050
Toll Free: 1 800 233 2955
Fax: [+1] (201) 934 9229
Telex: 910 710 991 9752

VENEZUELA

Marcoms De Venezuela C.A.
Edif Exagon Piso 5 OFC 57
Av Romulo Gallegos El Marques
Apartado 76702
CARACAS 1070A
Venezuela
Telephone: [+58] (2) 242 1110,
[+58] (2) 242 1590 or
[+58] (2) 242 1590
Fax: [+58] (2) 238 0068 or (2) 242 0241
Telex: 23049 DHMAR VC

ZIMBABWE

KDB Holdings (Pvt) Ltd
Elecombe House
P.O. Box 2500
HARARE
Zimbabwe
Telephone: [+263] (4) 758921
Fax: [+263] (4) 758928
Telex: 26069 KDB ZW

14/12/94